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A Suspension Bridge with Flat Cables of Riveted-Plate Construction.

A bridge of unusual character was built over the Oder River in Breslau, Germany, during the past two years. It is a suspension bridge, of 415 ft. span, for highway purposes. The supporting chains are pairs of flat bands composed of six layers of steel plate riveted together, four such bands (making 12 thicknesses of plate) for each chain. The floor load on the suspenders is distributed between the four bands of each cable by an interesting system of equalizer bars and links. The anchorage of the cables and the support of the stiffening trusses also have features of distinctive design. In addition, the bridge is notable for its carefully studied outline and esthetic features.

The general dimensions of the structure appear from Fig. 2, in addition to which it should be said that the cables are 65.6 ft. apart c. to c., being placed at the outer edge of the roadway for esthetic reasons. It will be seen that the backstays are of steep slope, and the sag of the cables is materially less than would have been possible without going below the top of the stiffening trusses. This latter feature was deliberately chosen for proper esthetic effect. The backstays, however, in the original design had been planned to have the same slope at the tower as the main span of the cable. In working out the design more fully it was found that this disposition of the backstays would have caused interference with certain buildings which it was desired to preserve, and the arrangement shown in Fig. 2 was adopted. This brought the anchorage masonry so close to the main piers as to make it advantageous to connect the two, thus obtaining better distribution of the horizontal forces at the foundation level.

The substructure is simple, but it may be noted that the anchorage, which is a single block of concrete, has embedded in it an elaborate system of transverse truss frames of steel members, in order to transmit the vertical reactions into all parts of it.

The construction of the main cables is shown in the sketch of the hanger detail in Fig. 3. As will be seen, each of the bands of a cable is composed of six 23x11-16-in. plates (in the backstays, 26x11-16-in.). The plates are spliced at alternate hangers (15 ft. 7 ins. apart). The joints of the individual plates are distributed over a length of about 7 ft., so that no more than two joints in each band occur at one point; top and bottom cover plates of the same size as the main plates supply the deficiency of section at the splices. The band is straight between bend-points at the hangers.

The adoption of bands for the suspension cables was due to the desire to secure maximum flexibility in vertical direction, in order to minimize the secondary stresses near the towers arising from temperature changes. The original plan was to detail the cable as a rectangular riveted section, 40x32 ins., but this was abandoned for the reason stated.

The cables as built have a gross section of 366 sq. ins. and a net section of 300 sq. ins. The maximum stress at mid-span for each of the two chains is 2,320 tons, composed of 1,693 tons dead-load stress, 550 tons live-load stress, 14 tons wind stress, and 63 tons temperature stress (for 72° F. change from mean).

The suspender equalizer connection, designed to distribute the suspender load equally among the four bands of each chain, is shown by the detail in Fig. 3; this design was originated by the contractor. The influence of temperature expansion being such as to cause greater sagging of the upper bands than of the lower, an unequalized connection would entail danger of concentrating most of the load on either the upper or lower pair of bands under different conditions, a danger avoided by the design used.

Attention is directed also to the saddles on the main piers and at the deflecting abutments of the anchorage, and to the end support and anchorage of the stiffening trusses. The saddles on the towers and at anchorage abutment are similar. The latter is shown in our view Fig. 5, which exhibits the construction clearly. It may be noted, however, that the segmental rollers under the shoes are 28 ins. in diameter, and are ribbed steel castings; they are unusual in having different length at upper and lower face, the upper face being 60 ins. long and the lower face 66 ins. A pair of rocker shoes over the rollers ensures uniform distribution of load on the rollers. The cable where it passes over the upper rocker shoe has a cast-steel spreader block between upper and lower bands, and a cover casting over the upper band, all through-bolted so as to hold the assemblage firmly together.

The end bearing of the stiffening truss includes a cantilevered holding-down beam, secured by an anchorage in the masonry below. This avoids any lifting of the truss under loadings or temperature conditions which produce negative reaction at this bearing.

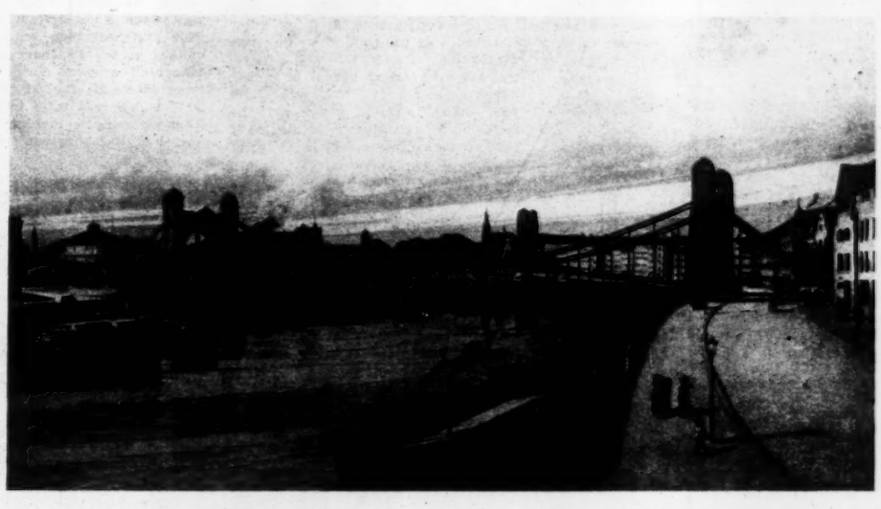

FIG. 1. THE NEW KAISERBRUECKE OVER THE ODER AT BRESLAU (FROM A WASH DRAWING). RIVETED-PLATE CABLE SUSPENSION BRIDGE, SPAN LENGTH 415 FT.

The bridge was the product of a competition for general designs, in 1905, which brought out several steel-arch and several suspension designs. The successful design, by Mr. M. Mayer and Prof. R. Weyrauch, is in substance represented by the bridge as built. The change in makeup of the chains and increase of slope of backstays have already been mentioned. The structural design was worked out by the city authorities, under direction of Stadtbaurat von Scholtz. The erection was under the supervision of Municipal Inspector Trauer. The superstructure contract was carried out by Beucheit & Co., of Grünberg, who made the detail designs and fabricated and erected the entire superstructure. The cost of foundations, piers and superstructure was about

$500,000 excluding river walls, approaches and real estate. The total cost will amount to about $900,000. The bridge was opened for traffic on Oct. 10, 1910.

An illustrated descriptive pamphlet was issued by the city authorities of Breslau for the inauguration of the bridge. Our drawings and the view Fig 1 are taken from this book, for which we are indebted to Stadtbauinspektor Dr.-Ing. Trauer. The photographs of Figs. 4 and 5 were taken last summer by Mr. Walton I. Aims, M. Am. Soc. C. E., of 45 Broadway, New York City, who kindly loaned them for our use.

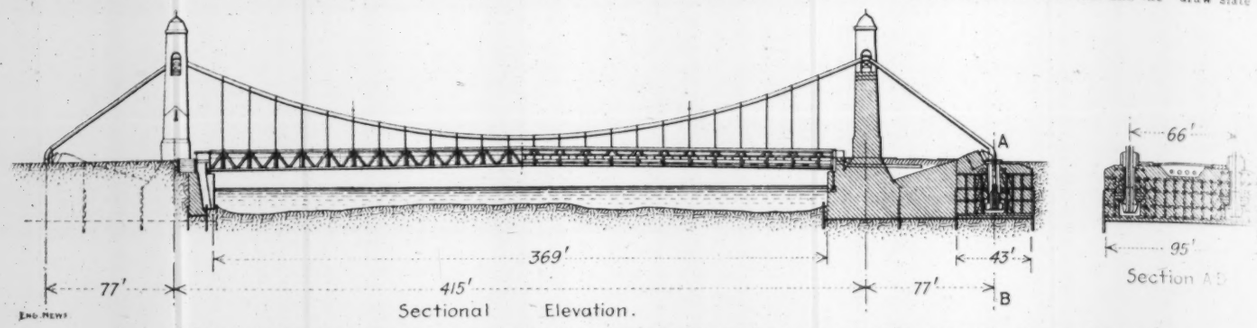

FIG. 2. OUTLINE ELEVATION OF BRESLAU SUSPENSION BRIDGE, AND CROSS-SECTION OF ANCHORAGE.

An Experimental Coal Mine for the Study of Gas and Dust Explosions.*

By GEORGE S. RICE,† M. Am. Inst. M. E.

The explosibility of coal dust in air having been successfully demonstrated in the 100-ft. gallery of the U. S. Bureau of Mines at Pittsburg, and in the longer galleries at Lievin, France, and Altofts, England, the next step in the investigation of coal dust explosions by each of the experiment stations was to determine the exact conditions under which such explosions took place. When these conditions were understood, tests of various preventative measures could be undertaken with some degree of precision. Prevention, or at least limitation, of explosions in mines was, of course, the real object of building the stations.

The gallery at Lievin, a short length of which was erected in 1908, has been gradually lengthened to a distance of 820 ft., and an increase to 1,600 ft. is under contemplation. The gallery at Altofts, also erected in 1908, was about 950 ft. long as originally laid out. In both these galleries the limitation of strength prevents safe loading with pure coal dust for more than a distance of 400 to 500 ft.; on loading beyond this distance the galleries are sometimes ruptured. The managements of these stations have expressed the desirability of making tests of coal dust in longer and stronger galleries, since it is impossible to solve all the problems surrounding an explosive wave in the short distances now available. Moreover, methods of limiting an explosion which were successful with a loading of coal dust for a length of 300 or 400 ft., would probably not be so with a longer loading or a larger explosion.

The Director of the Bureau of Mines, Dr. J. A. Holmes, and his technical staff, at an early date appreciated these unavoidable limitations of a surface gallery, and desired to obtain an underground gallery or mine opening, which would not only enable the tests to be made on a larger scale than is possible in external galleries, but in which experiments could be made under actual mining conditions. In such an underground gallery there would be no restriction as to the extent and violence resulting from explosion experiments, provided a suitable location was secured. Moreover, the methods of limiting and preventing explosions, the real objective of all such investigative work, could be tried out under real mining conditions.

It was foreseen that the greatest difficulties in experimenting in an underground gallery would be, (1) to obtain certain desired natural conditions and (2) having obtained these, to carry out and control the experiments in a scientific way, and to be able to get complete records in the face of violent explosions.

After a long search, a location for the experimental gallery, or mine, has been selected near Bruceton, Pa. From 2,500 to 5,000 ft. of straight entry can be driven from the outcrop in the Pittsburg seam. In some of the mines operating in the seam, in the past, great explosions have occurred.

The entries will probably be either level or slightly rising, except for irregularities so that there will be no serious problem of drainage. The entries enter from a steep sidehill and a cover of from 60 to 160 ft. is obtained. The openings are well located with reference to explosion effects, as there are no houses in the vicinity, except those needed in connection with the plant. The mine is fairly close to a railroad (one-third mile) so that the coal dug in advancing the entries can be loaded on railroad cars. By damming a ravine close at hand, water can be obtained for a boiler plant and for fire protection. Natural gas for experimental purposes and for use in a gas incline engine and fan engine is obtained from a pipe line which passes a few hundred feet from the mouth of the mine. Finally, the situation is near enough to Pittsburg to allow convenient movement of the engineers and physicists between the testing station there and the mine. The location of the mine is 12 miles southwest of Pittsburg on the Wheeling Division of the B. & O. R. R. The coal and necessary surface surrounding the mouth of the mine, has been obtained at a nominal rental from the Pittsburg Coal Company.

PROGRESS AND DEVELOPMENT.—After a long continued search for the best location, which would give the desired conditions, the present site was picked, and about the middle of December permission was obtained from the Secretary of the Interior and the Director of the Bureau to proceed with the laying out of the mine. The surveys already having been made, the outcrop was uncovered and two parallel entries with 40 ft. of pillar between them, were started. At the time of writing this description (March 16, 1911), these entries have been driven in under cover over 200 ft. The right-hand one, which will be considered the main entry, was started in the lower part of the coal seam, taking the top of the limestone, which is 5 ft. below the coal seam floor. Between the limestone and the coal seam there at this point a hard shale; the entry was excavated and in 5 ft. of the lower part of the coal seam up for a roof about 2½ ft. of the main seam.

After going in about 50 ft. in this manner, it was gradually raised on an upgrade until the ex was wholly in the coal seam and the "draw slate it. The so-called "draw slate" is a soft shale or clay which comes down immediately on Above it, as is generally the case in the in this district, there is 1½ to 2 ft. of coal" which is generally of poor quality and with layers of shale.

The parallel entry which will be called the a was driven wholly in the coal seam. It is not ded to use the mouth of this entry in explosion tests. For normal driving this air course will be the return and ventilation will be obtained by a small fan driven by gas engine located at the top of a small upcast shaft near the mouth of the air course. This shaft will be offset from the air course about 6 ft.

There will be another entrance to this air course, joining at about 150 ft. from the mouth, and which will enter at an angle of about 55° on the opposite side from the main entry. At the mouth of this side approach there will be placed a short length of concrete gallery with explosion doors, and beyond that a round steel gallery 120 ft. long, 20 ft. of which will consist of removable sections that can be rolled out of the way when it is desired to isolate the 100-ft. gallery. This part will then be identical with the 100-ft. steel gallery at the Pittsburg station, with one exception, a branch-off a short distance from the inlet to which a large reversible fan will be connected. This steel gallery, which is 6 ft. 4 ins. diameter, is made separable from the mine so that experiments similar to those conducted at Pittsburg can be made. The gallery at Pitts-

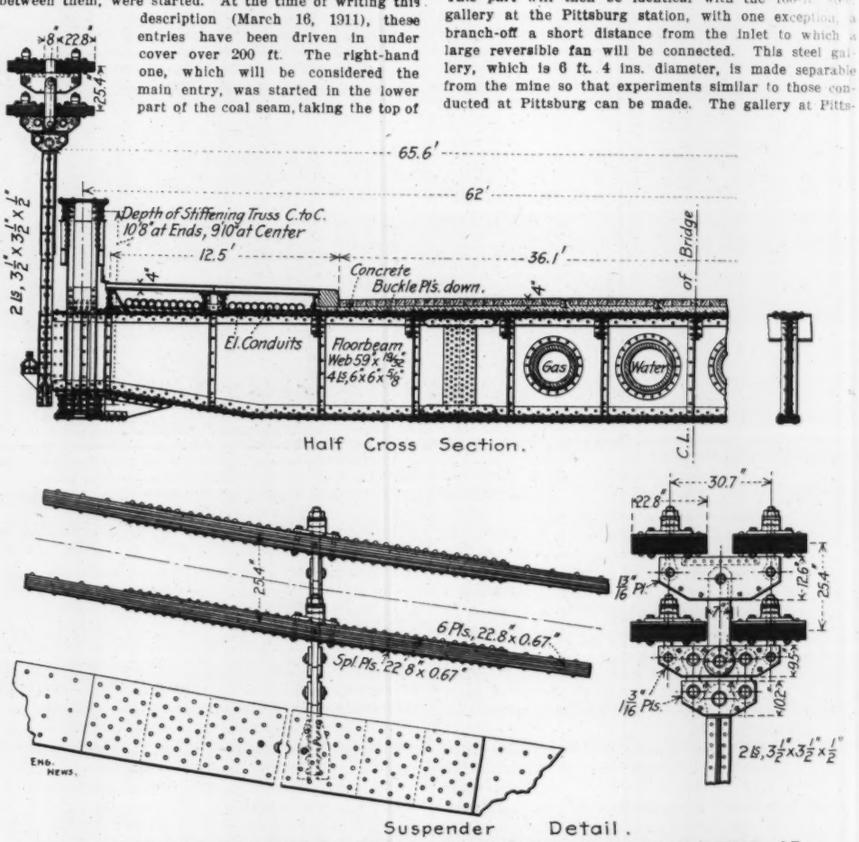

FIG. 3. HALF CROSS-SECTION OF BRESLAU SUSPENSION BRIDGE, AND DETAIL OF EQUALIZER CONNECTION OF SUSPENDER.

*From a paper presented before the Western Society of Engineers, Chicago Ill. April 5. Prepared by permission of the Director of the U. S. Bureau of Mines, Washington, D. C.

†Chief Engineer, Bureau of Mines, Testing Station, Pittsburg.

burg is so continuously occupied with the testing of explosives that systematic testing of coal dust cannot be undertaken in it. When the removable sections before mentioned have been rolled to one side and a steel door lowered in place to cover the connection into the air course, experiments can be conducted in the isolated gallery without interfering with operations in the mine.

CONCRETE LINING.—It is anticipated that great explosive force will be developed at the mouth of the gallery; hence it is intended that the timbering now in place must be supported by reinforced-concrete walls and arching. The latter will present a smooth surface to the explosive wave and thus prevent it from falls at the mouth of the mine, the occurrence of which would lead to heavy expense and delay in clearing up after each experiment.

The plan to concrete the approach leading from the gallery to the air course, and it may become necessary to concrete the air course, between this connection and the mouth, although it is not intended to load that portion of the air course with coal dust. It is expected that the explosion wave entering from the gallery entrance will not have gained sufficient momentum at the junction with the air course to break down doors or stoppings erected between that point and the mouth of the air course, but will be deflected in the air course toward the face.

Fig. 4. View on Roadway of Breslau Suspension Bridge, Showing Plate Cable and Hangers.

METHOD OF DRIVING ENTRIES.—The method of driving entries is the usual one employed in the Pittsburg coal seam. The coal is undercut and shot down with explosives, which in this case are of the "permissible" type, electrically fired. The coal is loaded on pit-cars, which are hauled by mules, to the mouth of the mine, thence over an outside tramway with slight descending grade, to the head of a rope incline. Trips of cars are lowered, by the hoist under brake, to a trestle and tipple located on a siding of the B. & O. R. R.

BUILDINGS AND APPARATUS.—It is necessary to have a considerable number of buildings; these are now under construction. There will be a boiler house with boiler to furnish steam for the several engines, including the fan engine. A crusher and grinder house will be necessary to grind up the dust for the experiments; as much as four tons will be necessary at a time when the mine is fully developed. There will be a blacksmith shop containing small equipment for the necessary repairs, and an engine house for the incline engine. There will be a combined office and observation room for observations and the starting of explosions, in connection with which there will be a small laboratory for field analyses of gas and mine-air samples. Several small buildings, including a barn for the mules, have already been constructed.

VENTILATING FAN.—The ventilating fan for the experiments must be of such size as to create all the conditions which may surround an explosion in a mine. It is desirable to obtain high velocity in restricted areas, say, 1,500 ft. per min. over a considerable distance. Capacities of 80,000 cu. ft. per min. at a pressure of 2 ins. of water and 15,000 cu. ft. per min. at a pressure of 6 ins. of water have been specified and guaranteed by the builders. The fan is made reversible so that experiments may be conducted with dust explosions going against the air current as well as dust explosions going with the air current. The Altofts' gallery fan is not reversible and the explosion portion of the gallery is at the intake end.

PRESSURE AND RECORDING INSTRUMENTS.—The important objectives of the experiments are to obtain (1) the speed of the explosion as indicated both by pressure and by flame; (2) the variation in pressures at different points along the course of the explosion; (3) the temperatures, and (4) the samples of the gases immediately preceding the inflammation of the dust or gas and immediately following the inflammation at a given point. Such experiments will require apparatus of an extremely sensitive nature. A set of instruments similar to those used in the Altofts' Gallery has been purchased from the Cambridge Scientific Instrument Company of England. These were designed primarily for external galleries, but it is believed there will be no serious difficulty in arranging them in steel plate boxes sunk into the coal rib. It may be found necessary to design new and additional apparatus.

To connect these instruments with the outside will require the wiring to be done in such a way that it will not be torn out by the explosions. It is proposed to place the wiring in pipes placed in a groove in the coal rib; at the mouth of the mine these pipes will be set in concrete but arranged with suitable boxes at short distances apart so that the wires may be inspected.

The purpose of this method of initiating explosions in the outside gallery of the experimental mine is to proceed from the known conditions in the gallery (as developed at the Pittsburg gallery) to the unknown conditions prevailing in mine entries. There is also another object, that while entries are being driven it will give double the length of travel for the explosive wave and thus allow the trying out of the mathematical instruments, before the final explosion experiments which may be originated in the interior of the mine.

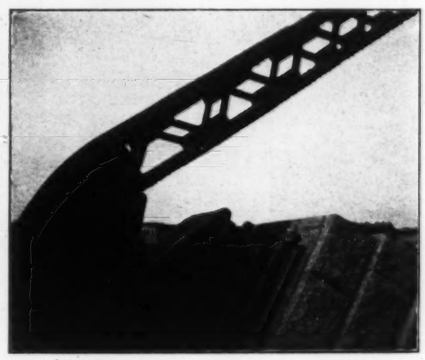

Fig. 5. View of Saddle Abutment at End of Backstay, Breslau Bridge.

FIRE-DAMP TESTS.—Besides making investigations of the explosibility of coal dust in pure air, it is intended to make tests with small percentages of methane in the air. It is generally recognized that a very slight amount of methane, even as low as ½%, may increase the chance of ignition of coal dust and more widely extend an explosion that has once been started.

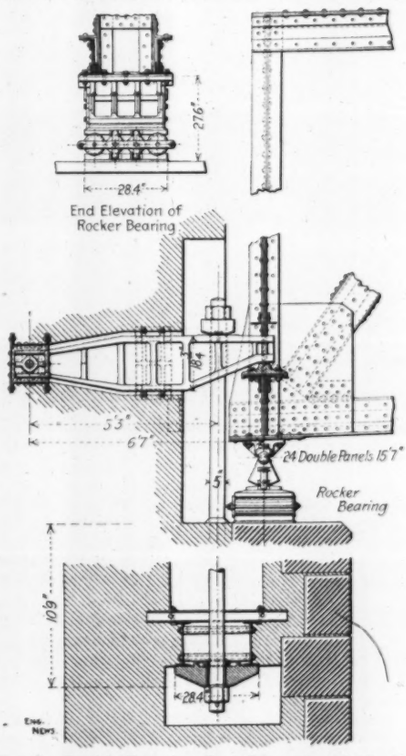

Fig. 6. Double-Reaction End Support of Stiffening Trusses, Breslau Suspension Bridge.

The location of the Experimental Mine is fortunate in having a natural-gas pipe line near it. This line takes gas from some gas wells in the same ravine. It is intended to run a branch from this gas main for use in a gas-engine hoist and in a gas engine for driving a small ventilating fan. It will also be used for the purpose above indicated, of introducing, when desired, small quantities of gas into the mine.

Natural gas has very nearly the same composition as the marsh gas of the coal seams, the difference being that in addition to the methane (CH_4) there is from 10 to 15% of ethane (C_2H_6). This slightly varies the proportion of the mixture of air for its combustion, but the difference for practical purposes is negligible.

The gas will be piped to certain points and by a system of mixing with the ventilating current, will be carried through in whatever proportions may be required, approximate percentages will be determined through meter measurements and precise determinations by sampling the air and gas mixture and analyzing. It is considered that this line of investigation of the effect of small percentages of methane is most important, and the need for it has been expressed by foreign critics of coal-dust experimentation now carried on.

DUST TESTS IN MINE.—At the start it is intended that coal dust explosions will be originated in the steel gallery and the explosion will enter the air course through the branch, pass up to the last open crosscut, through the latter into the main entry and out to the mouth of same. The crosscuts will be driven on a circle tangent to the entries. This will require one 45° turn and one semi-circular turn of the explosion wave, a condition which seems to cause no obstacle in a real mine explosion nor does it cause difficulty in the Altofts' gallery.

PREVENTING EXPLOSIONS.—The real importance of the experiments is not the mere study of explosion waves, although of great scientific interest, but to study methods for preventing or limiting explosions. It is, therefore, proposed to experiment with all the important methods that have been suggested up to date as described in U. S. G. S. Bulletin 425 and Bureau of Mines Circular No. 2, among which may be briefly recited, watering by water sprays, use of exhaust steam sprays and of deliquescent salts (like calcium chloride) and rock and shale dust in various ways. It is believed these experiments tried out in a mine on a sufficiently large scale can effectually demonstrate the relative efficiency of the various methods.

EXPLOSIVES, ETC.—A secondary purpose of the experimental mine, and by no means an unimportant one, is the study of explosives which have been placed on the permissible list for use in gaseous and dusty coal mines—testing them under actual working conditions in coal.

Another purpose to which the experimental mine can be put is in studying the relative production of inflammable dust by different types of machines which undercut or shear the coal.

Still another purpose is the testing out under mine conditions of gasoline motors to determine the safety of the apparatus in actual use and the degree to which the air may be vitiated by the exhaust gases.

It is probable that many electrical mining devices can be tried out under actual service, together with tests of insulation of wiring.

CONCRETE AND STEEL TIMBERS.—The growing scarcity of mine timbers, as well as the danger of fire from their use, suggests the importance of testing reinforced-concrete timbers and ties; also steel props and ties in the experimental mine. The relative advantages of brick arching and reinforced concrete for lining the main entries can also be studied, and under severe conditions.

It is probable that the equipment will be sufficiently installed by the first of May to try some preliminary experiments. In the meantime the entries are being driven as fast as possible.

SEWAGE DISPOSAL PLANTS IN CALIFORNIA were completed and put in operation during the year 1910 by 14 cities, according to a statement by Mr. N. D. Baker, Engineer Inspector of the California State Board of Health, in the Bulletin of that Board. A descriptive list of the plants follows:

Bishop	$3,975	Sewage disposal tank.
Monterey	4,750	Septic tank.
Pasadena	16,000	Septic tank.
Santa Clara	24,623	Disposal plant and sewer extensions.
Whittier (bonds)	110,000	Sewer system and septic tank.
East San Jose	29,900	Sewer system & disposal tank.
Bakersfield	14,500	Septic tank.
Imperial	33,346	Sewer system & disposal tank.
Mayfield	21,785	Sewer system & disposal tank.
Lodi	49,941	Sewer system & disposal tank.
Los Banos	28,639	Sewer system & septic tanks.
Newman	23,079	Sewer system and septic tank.
Colusa	27,808	Sewer system & septic tanks.
Corona		Sewer system & septic tanks.

In addition, plants were under construction or had been provided for by bond issues at the close of 1910 at Corning, Modesto, Orange, Oroville, Pleasanton, Roseville, Santa Paula, Tulare, San Luis Obispo and Sonoma.

Destruction of a 300-ft. Gantry Crane by Dynamite.

By J. C. PINNEY, JR.*

About 11.15 p. m., Thursday, March 16, a 300-ft. gantry traveling crane in the coal yards of the Milwaukee Western Fuel Co.'s Canal St. dock at Milwaukee, Wis., was destroyed by dynamite. Two blasts were fired about one-half hour apart. The first blast, according to the neighbors, was the more severe of the two and is the one which really wrecked the structure.

The crane was composed of two trusses of the riveted Pratt type with curved upper chord. The trusses were about 300 ft. in length and rested on a tower at each end which was equipped with motors for moving the structure in a lateral (east and west) direction. The lower chord was composed of built-up channel sections laced together with single lacing top and bottom. The verticals were of I-beams, the main diagonals

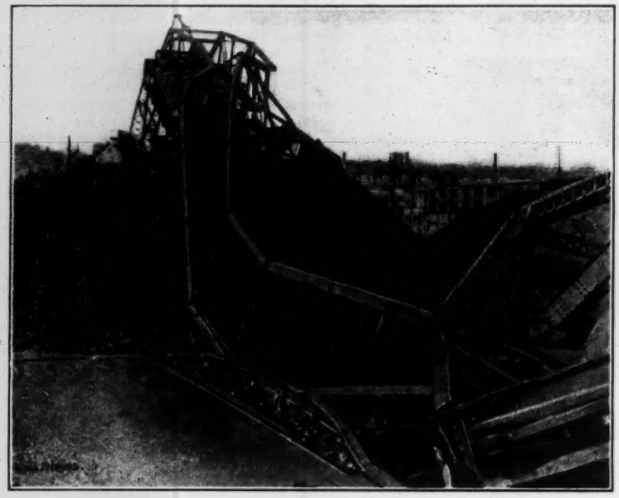

Fig. 1. Looking Along the Gantry Toward the North Leg.

of angles, either two or four according to location, and the counter diagonals of adjustable eyebars. The upper chord was composed of two 12-in. channels and a 16-in. cover-plate, with single lacing at the bottom.

From the panel-points of the lower chord were hung brackets to which were riveted 24-in. I-beams supporting the rails for the trolley carrying the grab bucket. Open-web floorbeams, placed high enough to clear the bucket traveler, supported a footwalk the full length of the structure.

The general character of the supporting legs is shown by Fig. 3, a view of the uninjured north leg. The north end of the crane was arranged so that the bucket could dump directly into cars through a hopper if desired. This tower rested upon two motor-driven trucks. The support at the south end was somewhat different, being a single bent not braced to the bridge like the north leg. Fig. 2 shows the east column of this leg as it lies after the explosion. The west column and the bottom strut were demolished by the explosion. Charges were placed in each truck of this support.

The first charge exploded in the west truck of the south leg of the structure. The column was torn completely loose from the truck, and the lower end of the entire frame was thrown eastward some 70 ft. or more, thus giving the entire crane a severe twist, plainly shown in Fig. 1. The truck itself was left practically unmoved, but its motor was blown some 20 ft. west and wedged in between the dock and a steel barge moored here for the winter. The second explosion, which according to the reports of the neighbors was less severe, was in the east truck of the south leg, and while it did not tear the column entirely free from the truck, nevertheless it completely demolished the truck. The motor was thrown against the barge.

The hinged cantilever at the south end of the crane, used for unloading ships, which was swung up at the time, fell upon the deck of the barge. The damage to the vessel was practically limited to buckling the web of one of the arched plate-girder floorbeams. This part of the crane was, of course, demolished. The side of the barge received a dent some 2 or 3 ins. deep and about 12 or 15 ins. in diameter.

As Fig. 3 shows, the north end of the crane is practically uninjured. The trolley and grab bucket were near this end and they escaped any considerable injury. They can be seen resting against the coal pile in Fig. 3. The rest of the structure is a mass of twisted steel.

As is to be expected from the severe twist given the structure, almost every kind of failure imaginable is exemplified in the various members. Joints have failed by direct tension and shearing of the rivets, buckling and tension of the members themselves, and also by cross-bending. The four views Figs. 4 to 7 show a few of the damage details.

The crane was erected by Heyl & Patterson, of Pittsburg, Pa., at a cost of $125,000. It was completed and put in operation last summer. The salvage is estimated at about $25,000.

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Fig. 2. South Leg of the Gantry Overturned by Destruction of West Truck.

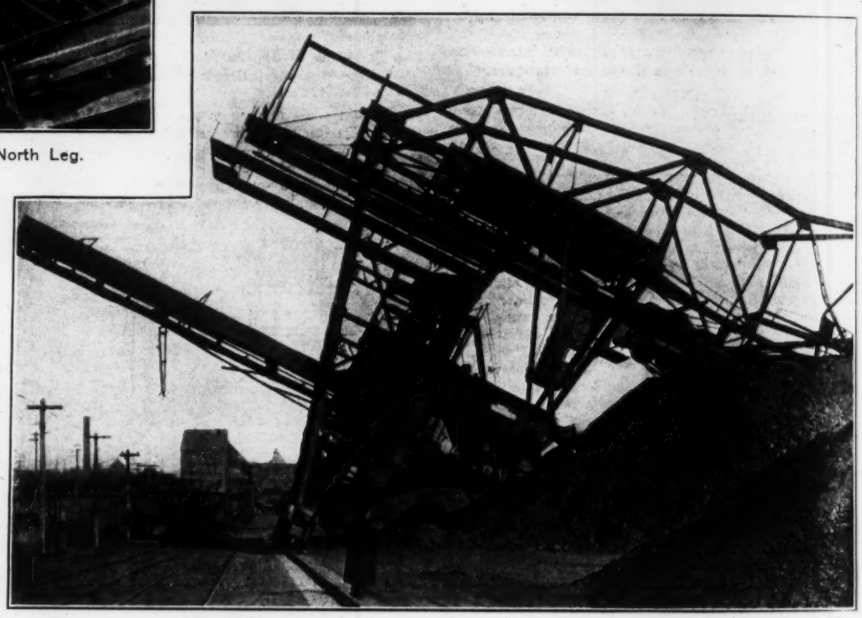

Fig. 3. North Leg of the Gantry, Not Damaged.

FIGS. 1 TO 3. RESULTS OF DYNAMITING A 300-FT. GANTRY CRANE OF MILWAUKEE WESTERN FUEL CO., MILWAUKEE, WIS.

London Traffic.

By H. R. WILSON.*

In February, 1903, the British Governme[nt] ap-pointed a Royal Commission to report [on] (1) measures deemed most effectual for the im[pro]ve-ment of the means of locomotion and tra[nsp]ort in London, by the development and int[egra]tion-nection of railways and tramways on or [be]low the surface, by increasing the facilities for [rap]ider means of mechanical locomotion, and by [the] provision for the organization and regula[tion] of vehicular and pedestrian traffic or oth[erwi]se; (2) the desirability of establishing some au[thor]rity or tribunal to which all schemes of railw[ays] and tramway construction of a local character should be referred and the powers which it would be advisable to confer upon such a body.

In September, 1903, the Chairman, four members of the Commission and the Secretary visited New York, Boston, Philadelphia and Washington.

Among the witnesses they heard were Wm. Barclay Parsons, Bion J. Arnold, H. H. Vreeland, E. W. Winter, Samuel Rea, E. M. Shepard, H. W. de Forest, Gen. W. A. Bancroft, G. C. Crocker, W. J. Wilgus, H. A. Carson, J. F. Jackson, John B. Parsons and W. S. Twining.

An Advisory Board of Engineers was appointed, which consisted of Sir John Wolfe Barry, the

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late ... Benjamin Baker and Mr. Wm. Barclay Par... Eight volumes, containing very volu- min... reports, were issued from time to time, fille... th valuable statistics and other informa- tion ... accompanied by useful maps. In a final rep... numerous recommendations were made, bu... principal of these was that a permanent b... appointed to deal with questions of l... locomotion.

Th... final report appeared in the summer of 1905, ... as yet the London Traffic Board has not b... appointed. It would take up too much space ... explain why this is, but the reason is mai... political. The Balfour Gov- ernm... was in power when the repor... s presented, and in Novem- ber, 1... it was announced that the

Fig. 4. Upper Chord Joint of East Truss Torn Apart.

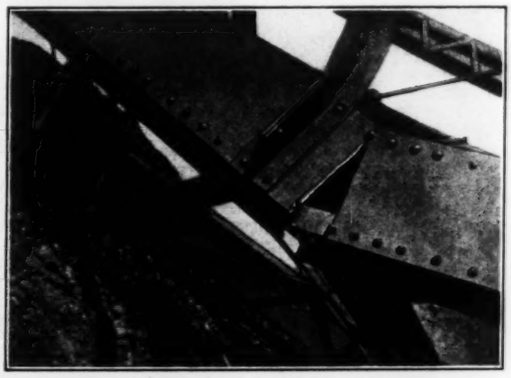


Fig. 5. Break in Upper Chord, West Truss.

Fig. 6. Crack in Web of 24-in. I-Beam.

Fig. 7. Web of 24-in. I-Beam on Coal Barge Shattered by Fall of Cantilever Extension of Crane.

FIGS. 4 AND 7. DETAIL VIEWS OF DAMAGED PARTS; WRECK OF GANTRY CRANE AT MILWAUKEE.

concert between the departments interested—the Home Office, Board of Trade and Local Government Board—and he promised the most respectful consideration from His Majesty's Government. The Government has, however, since had its hands full of bigger questions and nothing has yet been done.

The establishment of the London Traffic Board was a small matter, but it is bearing good fruit, as may be judged from the three annual reports that have appeared. In the first report Sir Herbert Jekyll said that he had examined and reported on all Parliamentary proposals relating to London Traffic, that he had also examined schemes that had not got as far, and had taken part in departmental conferences upon subjects relating to locomotion in London. He then stated that the preparation of a comprehensive plan of street and road improvement was greatly needed.

preparation of a bill for the establishment of a Board had been sanctioned. The administration retired immediately after, and the Liberal party, now in power, has not taken kindly to the suggestion. They did, however, in August, 1907, create a minor department in the Board of Trade to be known as the London Traffic Branch, and this was put in charge of Sir Herbert Jekyll, then the Assistant Secretary of the Railway Department. Its duty was to consider new schemes of locomotion, seeking statutory authority (as far as they came within the scope of the Board of Trade) to collect information to prepare an annual report on the whole subject of London Traffic for presentation to Parliament and to carry out any additional duties that it might be called upon to discharge.

The first annual report of Sir Herbert Jekyll appeared in November, 1908, and a few days later the Prime Minister received a deputation from the London County Council, who informed him that, contrary to the general idea that prevailed, they did not desire to be the authority on traffic but recommended that an advisory board, having judicial powers only, should be appointed. Mr. Asquith, in reply, said that he viewed with distrust the creation of any new authority and that there was already a superfluity of authorities. On the other hand, he was struck with the want of concert, with the want of provision, with the want of co-ordination, as regards routes and as regards competing forms of traffic which has characterized, and continues to characterize, Metropolitan action. Before anything further could be done there would have to be consultation and complete consideration in

The second report was dated October, 1909, and it was therein stated that an increase in the staff of the Board had been sanctioned which would allow for the investigation of special subjects, the chief of which was the question of arterial roads. This enquiry would involve the examination in detail of an area of 700 square miles with reference to its topographical features, the distribution of population, the extent to which it is occupied by buildings, the areas suitable for occupation, which have not yet been built upon, the probable course of future development, and the facilities for locomotion which either exist or are likely to be required.

The third report appeared a few weeks ago. In it the defects of the existing roads are set out in some detail and suggestions are made in regard to measures which it would be desirable to take to make good deficiencies, and generally to bring the capacities of the main thoroughfares up to the requirements of present and prospective traffic. It records a great increase in the number of journeys made by Londoners during the year as may be judged from the figures given in the table at the bottom of this page.

It is then remarked that there is still a considerable margin for expansion before the limit of capacity will be reached, while the traffic of the suburban railways might be largely increased, even in existing conditions and still more by an extended use of electric traction.

In the opinion of Sir Herbert Jekyll an arterial road should be wide enough for at least two lines of moving vehicles on each side of the street-car lines, in order that fast traffic may pass unchecked at normal speed. Thus, the roadway of a main thoroughfare with shops on both sides ought to accommodate a double line of street-car tracks and six lines of ordinary traffic—three on each side. In extreme cases it may even be necessary to allow for four lines of traffic on each side—one standing and three moving. On the other hand, where there are either no shops or shops on one side only, the width of roadway may be proportionately reduced. It is recommended that the following standards of width for roads of different classes be adopted:

Main arterial roads not less than	100 ft.
First-class county roads, either radiating or connecting places of importance	75 to 100 ft.
Second-class county roads	50 to 75 ft.
First-class district roads, connecting villages or forming branches of main or county roads	35 to 50 ft.
Second-class district roads, mostly country lanes	25 to 35 ft.

A long list follows as to the new roads that ought to be provided and existing roads to be improved. These have a total length of 99.90 miles of new roads and 25.45 miles of existing roads. The expense will be great, but Sir Herbert Jekyll says it should be remembered that the cost of inaction is also heavy. The time lost daily by millions of people, through insufficient road-accommodation, is alone equivalent to a loss of money which, although impossible to estimate with accuracy, must be very large. He further emphasized the fact that the longer improvements are postponed the more costly they will be.

In support of the latter argument a map is given, showing the buildings and detail as they existed in 1891-4, and marked thereon in blue are the additions made up to 1901, and in red the changes since the latter year. This map shows the progressive closing of vacant spaces. Routes for new roads which were open in 1894 were no longer available seven years later, or could then only have been adopted at greatly increased cost, owing partly to the growth of building and partly to the enhanced value of land. Improvements which might have been made at no excessive cost eight years ago, are now hopelessly blocked by new buildings, railways and other obstructions.

That there has been a great change in the class of vehicle plying for hire on the London streets may be judged from the accompanying figures for the years 1903, 1908 and 1909. The return for 1908 is given so as to see the changes within the last year:

It is considered that the reduction in the number of cabs has undoubtedly tended to relieve

GROWTH OF LONDON PASSENGER TRANSPORTATION.

Number of Passengers Per Year.

	Local railway companies.	Street cars.	Omnibuses.	Total.	Estimated population of Greater London.	No. of journeys per hour.
1903	290,722,680	394,356,531	287,386,471	972,465,682	6,806,296	142.9
1909	440,744,610	687,138,908	311,000,000*	1,408,883,518	7,429,740	189.6

*Estimated.

Number of Vehicles for Hire.

		Four-wheel vehicles			Omnibuses			Street cars			Total of all vehicles.
Year.	Hansoms.	Horse.	Mechanical.	Total.	Horse.	Mechanical	Total.	Horse.	Mechanical.	Total.	
1903	1,499	3,905	....	4,455	3,623	13	3,636	1,143	576	1,719	16,760
1908	4,826	3,649	2,805	11,280	2,155	1,133	3,288	323	2,003	2,326	16,894
1909	3,299	3,263	3,956	10,518	1,771	1,180	2,951	239	2,198	2,437	15,906

FIG. 1. MAIN STREET VIADUCT ACROSS O. K. CREEK VALLEY, KANSAS CITY, MO.

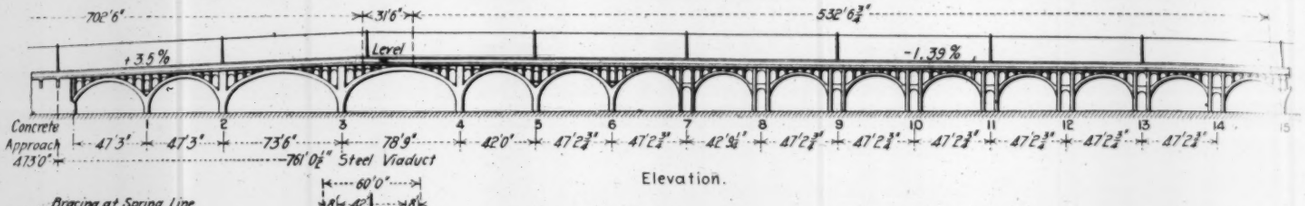
the congestion of traffic in the streets, for not only are there fewer cabs in motion but cab-ranks are shorter than they were, and the obstruction caused by crawling cabs has been much reduced.

In the references to motor omnibuses it is stated that the Commissioner of Police, in March, 1909, intimated to the proprietors of motor omnibuses that, in his opinion, the vehicles then in use had the inherent defects of excessive weight and liability to cause undue noise after comparatively short periods of continuous use. He gave notice that he would not in future be prepared to license any omnibus which exceeded 3½ tons (of 2,240 lbs.) in weight. The type of omnibus that has been introduced in consequence of these regulations travels about 7½ miles for each gallon of petrol, as compared with about five miles traveled by one of the older type.

On certain routes, motor omnibuses compete successfully with the street cars. The speed of the latter is greater when in a wide road and traffic is not congested, but in comparatively narrow roads, where traffic is dense, the motor omnibus is faster because, unlike a street car, it can thread its way among other vehicles.

As to railways, the report says that the electrification of suburban railways would confer great benefits upon the public. It would increase the facilities for traveling, bring the suburbs closer to the center of London in point of time, and stimulate the outward movement of the population. The progress of electric traction on railways has been somewhat hindered by doubts as to the best system to adopt. The report then observes:

Though the rival merits of the two systems are the subject of acute controversy among experts, they have a comparatively small bearing on the larger question of the expediency of electrifying steam railroads. Both systems give such good results that so far there would appear to be little to choose between them in point of efficiency, though each has qualities of its own which make it more or less applicable in particular circumstances and conditions. The importance of the early adoption of a uniform system has been strongly urged by some authorities on the ground that, although the particular systems selected for isolated installations of limited extent may be a matter of comparative ence at first, extension is to be looked for in th course of development, and that, as soon a meet, difficulty in the interchange of traffic, break of gage, will at once arise if the system ferent. Others are of opinion that no such need occur if local lines were separated from m and the services were kept distinct, as they be. They hold that every railway company sh free to select the system that suits it best, and impose a uniform system upon all railways wo a needless burden upon some of them, and w to retard the development of suburban electri



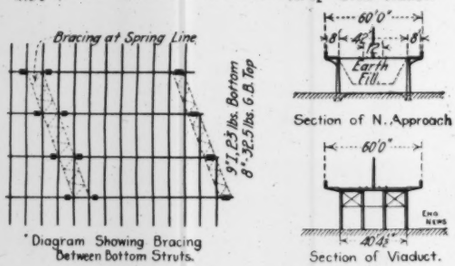


FIG. 2. OUTLINE ELEVATION OF MAIN STREET STEEL ARCH VIADUCT, KANSAS CITY, MO.

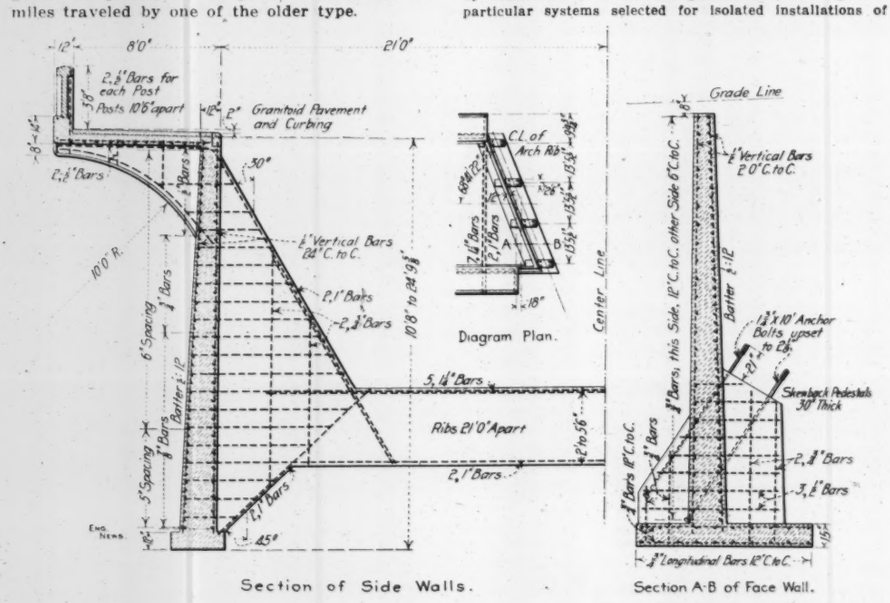


FIG. 3. MASONRY DETAILS OF NORTH APPROACH, MAIN STREET VIADUCT, KANSAS CITY, MO.

Main Street Steel Arch Viaduct Over O. K. Creek Valley, Kansas City, M

By KENNETH HARTLEY.*

As Kansas City spread from the Missouri River back into and over the hills to the south, the valley of O. K. Creek seemed for a time to be the natural boundary, and the Kansas City Belt Ry. in encircling the city followed O. K. Creek, crossing Main Street at what is now Twenty-second St. A high bluff just south of the creek interposed a formidable barrier to the opening of any streets across the valley at this point, so that in spite of the growth of the city to the southward there has been no crossing between Grand Ave. and Broadway. Now one-half of the population and two-thirds of the area of the city are south of 22d St. and the need of an additional north-and-south thoroughfare in this central part of the city has become great enough to warrant cutting down the bluff and building a viaduct across the tracks in the valley.

An impetus was given to this project by the decision of the railways to build a new union station on this tract of land, with the consequent possibility that its traffic might be brought north on some other street than Main. To avoid this an association of business men raised the money by private subscription to build the viaduct from 20th to 23d Sts., a distance of 1,260 ft. When completed the viaduct will be given to the city.

Work on the foundations and north approach was commenced in the fall of 1908, the steelwork was erected in the summer of 1909, and the concrete floor was finished in April, 1910. Work has been carried on slowly because of the fact that the south approach forms part of the east approach of the new union station and is to be built by the station company in connection with their construction work. The viaduct cannot be opened for traffic until the station company is ready to build its part.

In the north approach, the first portion of 160 ft. south from 20th St. was built with retaining walls located at the property line on each side of the street, the entire street space being filled to the new grade. From this point to the north abutment, 350 ft., the retaining walls are at the curb line and the sidewalk is carried on reinforced-concrete brackets (Fig. 9). The steel structure, Figs. 1 and 2, consists of 15 spans of plate-rib arches varying from 38 ft. 3 ins. to 78 ft. 9 ins. in length center to center of columns. These carry steel floorbeams on 5-ft. 3-in. spacing, supporting a reinforced-concrete slab floor 42 ft. wide between curb lines and 60 ft. wide over the bracketed sidewalks. There are four ribs on the width of the bridge, spaced 13 ft. 4 15/16 ins. on centers.

The viaduct was designed for a live-load of

*Civil Engineer, 1500 Grand Ave., Kansas City, Mo.

two 40-ton street cars on each track, a concentrated load of 24 tons on two axles 10 ft. centers on any part of the roadway, and a distributed load of 100 lbs. per sq. ft. on all other parts of the roadway and sidewalk. An allowance for impact was made by adding 25% to the live-load for the arch ribs and 50% for the floorbeams and connections.

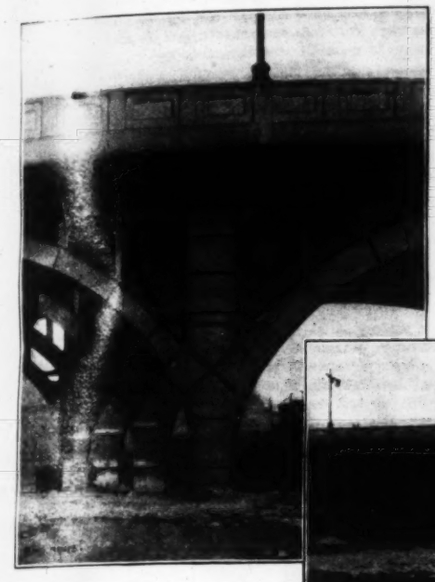


Fig. 4. Interior of Reinforced-Concrete Box, North Approach, Main Street Viaduct, Kansas City, Mo.

FIG. 5. A SINGLE-LEG COLUMN (COL. 2) AND A TYPICAL ARCH SPAN, MAIN STREET VIADUCT.

APPROACH.—The reinforced-concrete walls of the north approach are not designed as retaining walls, but the whole structure is considered as a bottomless box, the entire horizontal pressure of the earth fill as well as the moment of the sidewalk brackets being resisted by transverse tie-walls 21 ft. apart, the side walls acting as continuous beams to carry the earth pressure between these points. The batter of ½ in 12 on the outside of the wall gives sufficient increase of thickness toward the bottom to take care of the maximum pressure with a very moderate percentage of steel. A large saving was effected by this design, Fig. 3, both in concrete and in excavation, as compared with the most economical type of reinforced retaining wall, at the same time eliminating all danger of unequal settlement and sliding of footings on the clay soil. The appearance of the concrete box before filling with earth is shown by Fig. 4.

PIERS.—All piers south of Col. 7, where the double-leg column construction begins, were carried down to rock so that the Terminal Railway Co. may excavate around them without danger. These piers will eventually be removed and the columns supported on steel girders over a subway for handling baggage and express.

SUPERSTRUCTURE.—The southerly half of the viaduct crosses the east end of the platforms of the new Union Station and the span length of the arches for this part of the structure is fixed by the distance center to center of platforms. By a slight shifting of the freight and industrial tracks north of the platforms it was found possible to use a uniform panel length for the floor system 5 ft. 3 ins. throughout, and the distance between the arch ribs was made such that the skew was just sufficient to bring the second panel point of the second rib opposite the first panel point of the first rib, which permitted keeping all the floorbeams parallel and at right angles to the center line of the viaduct.

The original design had single-leg columns (as in Fig. 5), in the center of each platform, but this had to be changed to the double column construction to permit the installation of baggage elevators for raising baggage trucks from the subway, which will have to be located on the center line of the platforms. The change has not injured the appearance of the viaduct as much as was feared, and as it is in perfect harmony with the design of the train-sheds the general effect will probably be better after the station is completed than in the original design.

ARCH DESIGN.—The stresses in the arch ribs were analyzed according to the method of Prof. Wm. Cain on the assumption that the end tangents were fixed in direction. Fixity of the ends was approximately realized by extending the columns through to the floor of the viaduct for Bents 1 to 6, and for Bents 7 to 14 by supporting the skewback-girder on two columns thus compelling it to move in a horizontal plane under the effect on any unbalanced thrust.

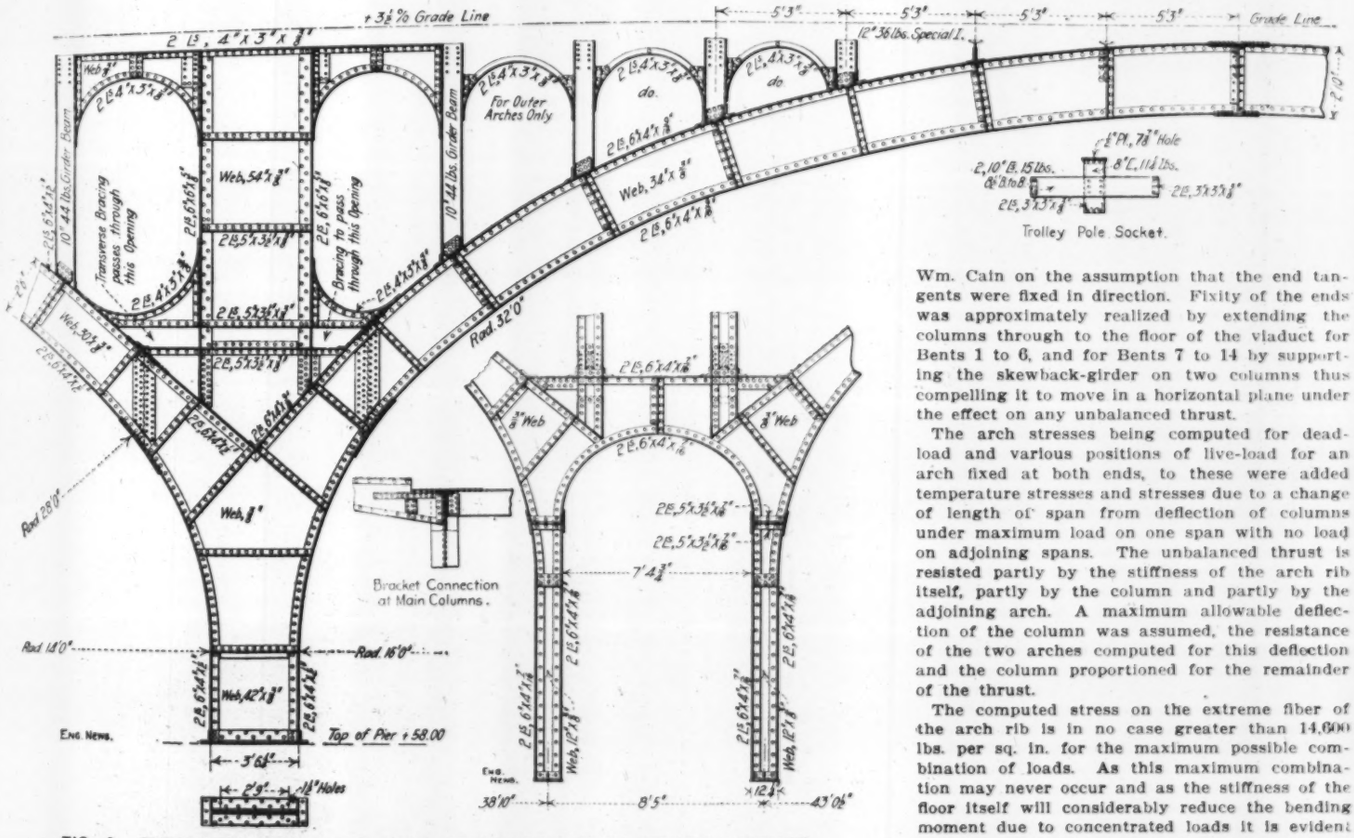


FIG. 6. TYPICAL DRAWINGS OF ARCH STEELWORK, MAIN STREET VIADUCT, KANSAS CITY, MO.

The arch stresses being computed for dead-load and various positions of live-load for an arch fixed at both ends, to these were added temperature stresses and stresses due to a change of length of span from deflection of columns under maximum load on one span with no load on adjoining spans. The unbalanced thrust is resisted partly by the stiffness of the arch rib itself, partly by the column and partly by the adjoining arch. A maximum allowable deflection of the column was assumed, the resistance of the two arches computed for this deflection and the column proportioned for the remainder of the thrust.

The computed stress on the extreme fiber of the arch rib is in no case greater than 14,000 lbs. per sq. in. for the maximum possible combination of loads. As this maximum combination may never occur and as the stiffness of the floor itself will considerably reduce the bending moment due to concentrated loads it is evident that the ordinary working stress is very much less than this, and the factor of safety is be-

lieved to be amply sufficient to cover any irregularity in the elastic action of the structure or any probable displacement of the footings.

The arch ribs are of I-shaped girder section, 20 to 34 ins. deep, with 12-in. flanges (Fig. 6). The bracing consists of a horizontal truss connecting the columns of each bent near the spring-

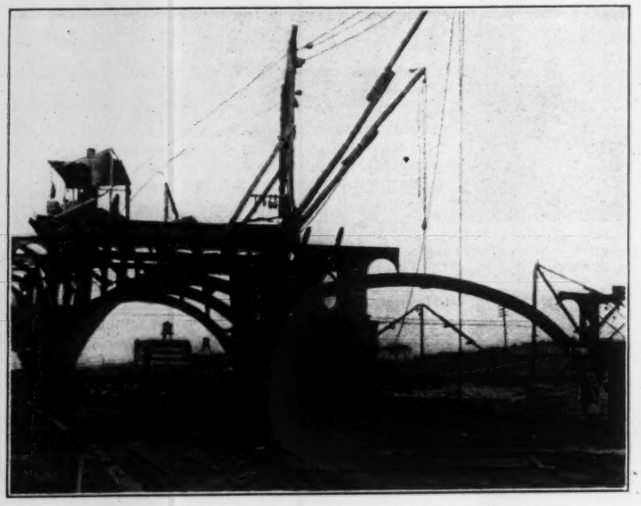


FIG. 7. ERECTION OF ARCH STEELWORK OF MAIN STREET VIADUCT.

ing of the arches and transverse sway-bracing from this point to the floor system. The concrete floor itself is depended upon for lateral stiffness. There is no bracing between the arch ribs.

A great deal of study was given to the detailing of the steelwork in order to avoid any appearance of clumsiness in the connections and at the same time develop the full strength of the arch ribs and secure the condition of fixed ends which had been assumed.

No latticed struts are used in the bracing; 9-in. wide-flange beams were preferred, on account of neatness of appearance and better surface for painting.

The total weight of steel was 1,400,000 lbs., or about 1,840 lbs. per lineal foot of viaduct.

EXPANSION JOINTS.—The expansion joints in the concrete floor are believed to be a novel idea. The joint is not made on a beam but halfway between two beams, the portion of the floor between the joint and the nearest beam being designed as a cantilever, reinforced in the top (Fig. 8). This location of the joint avoids any sliding bearings and affords no place for the accumulation of dirt. The joint was made by putting a piece of binder's board ⅛-in. thick against the end of a finished section of floor and pouring the concrete for the next section against it. The boards were left in the joints but will probably fall out in time. A 4 × 2½-in. steel tee was placed in the top of the joint while the concrete was soft; this tee will be coated with hot asphalt before the pavement is laid so as to seal the joint. No joint is to be made in the pavement itself, as the movement at each point is expected to be too small to do any harm. A creosoted wood block pavement is to be used.

Unified Electric Systems Covering Large Territories.*

By WILLIAM B. JACKSON.†

To provide electric light and power for a densely settled district, except in cases of very large cities, is comparatively simple, for this requires an organization and plant for a limited and homogeneous community. But for the larger possibilities of service, which means the tying together of many cities and towns, villages, and even outlying homesteads, by a great network of transmission and distribution lines, a more complex problem is presented.

To realize one of the material operating advantages of unified electric systems, the general direction of the operations of the company must be centralized, while the local characteristics and requirements of each community must be intimately considered, if the most satisfactory service is to be provided. This requires an organization controlled by exceptionally broad and discriminating engineering and commercial judgment.

Several factors tend toward making it economically possible to serve any territory from a comprehensive transmission and distribution system as a substitute for disconnected central stations located in the cities and villages. These may be here summarized as follows:

(1) Saving in power-house equipment made possible through taking advantage of the diversity of different communities by serving them from the same transmission system. (2) Lower power generating cost per KW.-hr. due to larger power plants and improved load factor. (3) Less investment in power plants per kilowatt capacity on account of larger plants as compared with smaller. (4) The possibility of decreased percentage of spare apparatus by appropriate arrangement of power plants. (5) Saving in cost made possible by centralized management, general superintendence and other ge... penses. (6) The possibility of providing rural ... burban service that could not be profitably re... a local central station. (7) The possibility of l... porations providing power service which would ... extensive for small companies to undertake ... development of water powers for electric servic...

The savings made available by the above ma... against the losses occasioned by the transmissio... formers and lines and the cost for their current ... tenance, deferred maintenance and interest on ... ment, to determine whether a unified system or ... ber of separate plants can most economically ... territory.

In less than 15 years the generation of elect... from water powers and its transmission and d... has become an important industry in almost a... of the United States. And it has carried th... of electricity to many regions that otherwise ... be served.

HYDRO-ELECTRIC SYSTEMS.—The scope ... of our hydro-electric systems is illustrated by ... ing brief consideration of a few representative ...

In the region tributary to San Francisco ... Sacramento the transmission and distribution ... of a single company serves a district comprising ... 12,000 sq. miles, which is an area 50% greater th... entire state of Massachusetts. Broadly speaking, ... territory tributary to the circuits is nearly three ... as great an area. The company serves more than ... cities and villages and the greatest air-line distan... between any two points on its system is over 200 mile... or about the distance from Niagara Falls to Utica, New ... York. Much of the region served could not economically ... receive the benefits of electric service except by some ... extensive system such as that under consideration.

The Los Angeles and Redlands district is ... served by two great electrical systems which cover an area of fully 1,000 sq. miles and provide electric service throughout the entire district, city and rural.

In the Middle West, the two electric-power companies in the vicinity of Grand Rapids and Battle Creek, Mich., are good examples of well developed and rapidly expanding hydroelectric systems. These serve 25 cities and villages ranging in size from 90 to 112,000 inhabitants, 12 of the villages having populations of less than 1,250 each. These companies also provide power for a number of interurban and city railroads.

An interesting example of a small but rapidly expanding transmission and distribution system is that of the Janesville Electric Co. in Wisconsin, which now utilizes four water powers and provides service to four cities and hamlets and some rural service.

In the East the effect of hydroelectric development in bringing to large territories service from single com-

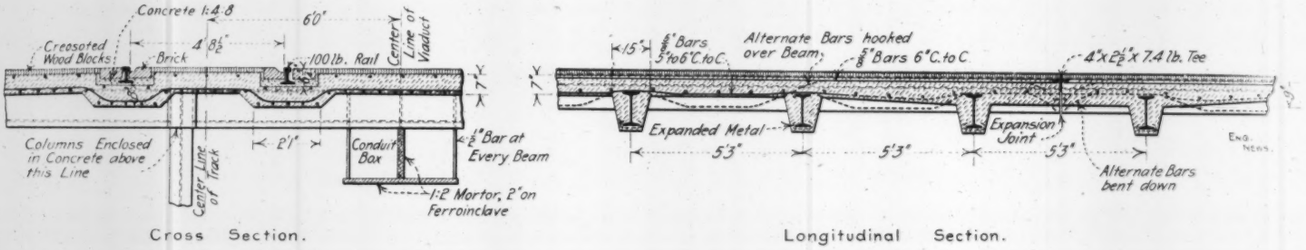


FIG. 8. FLOOR-SLAB DETAILS, SHOWING CANTILEVER EXPANSION JOINT.

*Abstract of a paper before the American Institute of Electrical Engineers, New York City, Feb. 10, 1911.

†D. C. & W. B. Jackson, Chicago.

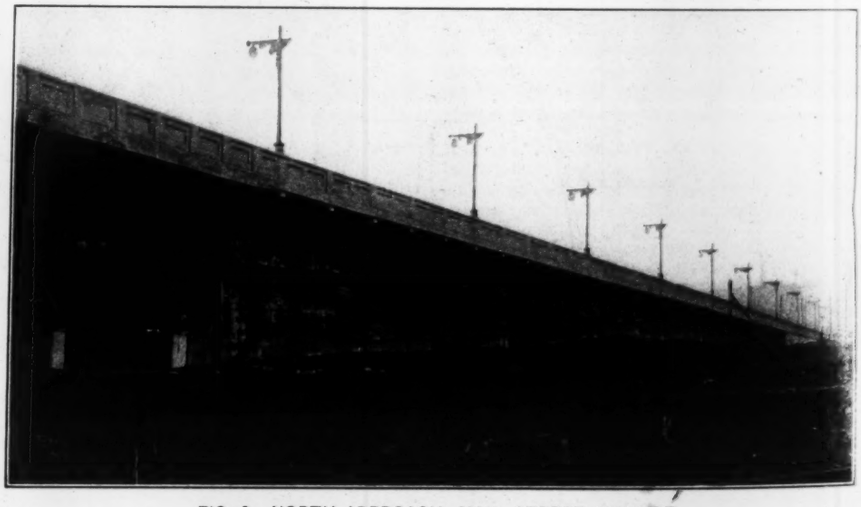


FIG. 9. NORTH APPROACH, MAIN STREET VIADUCT.

chensive electric systems is well illustrated by the tem of the Hudson River Electric Power Co. This pany serves 13 cities and villages together with a e mileage of electric railroads.

the South, the Southern Power Co. has created a re- able electric system in North and South Carolina. y of the companies having electric systems cover- rge territories have not made serious endeavor to rural patronage but I believe it is safe to predict is patronage will be more earnestly sought as progresses, and it should be a policy of such com- to so arrange their systems and organizations they can suitably provide the service.

STEAM-ELECTRIC SYSTEMS.—With the perfecting of transmission and distribution methods came the practica- bility of displacing small central stations by electric current transmitted from relatively large steam generat- ing stations. Much the same conditions exist with steam- electric transmission as with hydroelectric plants except that the locations of the power plants may be influenced by considerations and characters of the market.

A good example of a well developed and rapidly ex- panding system, emanating from steam-power plants, is that of the North Shore Electric Co., which serves a district covering 1,200 sq. miles surrounding Chicago. It supplies electric current to 60 cities and towns varying in population from 27,000 to 100 people each. Nineteen of these have less than 1,000 inhabitants each, and it is doubtful if one-third of the towns could have adequate electric service were it necessary for them to depend upon local central stations for supply.

Another system, the major portion of which is fed from steam plants, is that of the Eastern Michigan Edison Co., which is a comparatively new and rapidly expanding system. It covers a territory of over 900 sq. miles extending east and northeast from Detroit, and serves 19 towns ranging in size from 150 to 19,000 inhabitants. Only eight of these towns have a population of over 1,200 inhabitants each.

A system that is well developed and has been steadily expanding for many years is that of the Edison Electric Illuminating Co. of Boston. The company comprehen- sively covers the territory of Boston and its environs, extending 24 miles westward from the harbor and ex- tending in a north and south direction 26 miles, aggre- gating about 625 sq. miles. In addition to the corporate city of Boston, which has a population of over 670,000 inhabitants, the company serves 35 cities and towns ranging in population from 800 to 77,000 inhabitants. Of these municipalities, nine have populations of less than 2,000 people each, 26 have less than 10,000 inhabitants each, and five (besides the city of Boston) have over 25,000 inhabitants each. Many of these municipalities contain within their borders a num- ber of villages or hamlets which are more or less distinct from each other. Much of the territory is densely pop- ulated, but the townships comprising about one-third of it have a population averaging less than 100 people per sq. mile.

The above instances serve to illustrate the strides that have been made in the development of extensive trans- mission systems fed from steam plants. One may truth- fully say that a start has been made toward covering the rural districts of the United States with electric cir- cuits which should ultimately make it practicable to provide electric service to substantially all urban, subur- ban, and rural districts, wherever located; and excepting the possibility of some epoch-making discovery, the cre- ating of comprehensive consolidated systems of distri- bution appears to be the only way in which such a result can be accomplished.

SAVING IN POWER-HOUSE EQUIPMENT.—The ques- tion of diversity factor as between various communities which are provided with electric service from a single transmission system is quite complex. By diversity factor is here meant the ratio of the sum of the maxi- mum peak loads of separate plants which would serve the individual communities to the maximum peak load that would occur if the plants were combined. The condition may be illustrated by a consideration of the load curves of four central stations in the Northwest. One of these (Plant 1), serves a city of 50,000 inhab- itants with mostly business and residence lighting ser- vice and has a maximum output of over 900 KW.; the second (Plant 2), serves a city of 20,000 inhabitants having a good lighting and commercial power load to- gether with the local street railway service, and has a maximum output of 1,250 KW.; the third (Plant 3), serves an agricultural town of 4,000 inhabitants and has a maximum load of approximately 105 KW.; and the fourth (Plant 4), provides only business lighting and power service, and has a maximum load of over 790 KW. These are highly dissimilar in their characteristics and give the following result as regards diversity factor:

	Maximum individual peaks during the year.			Largest coincident peak during the year.		
	KW.	Date.	Time.	KW.	Date.	Time.
Plant (1)...	920	Jan. 22	8 p.m.	790	Dec. 23	5 p.m.
Plant (2)...	1,250	Nov. 12	9 a.m.	1,190	Dec. 23	5 p.m.
Plant (3)...	104	Nov. 15	6 p.m.	74	Dec. 23	5 p.m.
Plant (4)...	794	Dec. 27	5 p.m.	784	Dec. 23	5 p.m.
Total..	3,068			2,838		

There is therefore a difference of 230 KW. between the largest coincident peak and the sum of the maximum peaks, which represents a diversity factor of 1.09. This seems a surprisingly small advantage from the combi- nation, but it would allow a corresponding reduction in machinery to carry the peak load in a unified transmis- sion system over what would be necessary if the max- imum peaks were coincident, and would correspondingly improve the load factor over the average of the separate plants. The reduction in peak here indicated is equal to more than twice the maximum load of the smallest plant referred to.

When plants (1) and (2) only are combined, the time of their largest coincident peak is the same as in the foregoing case so that for these two plants there is a difference between the coincident peak and the maximum peaks of 190 KW. and a diversity factor of 1.10. This saving in peak capacity amounts to 21% of the smaller maximum peak and a combined plant would need only 79% of the smaller peak capacity added to the larger.

Considering plants (1) and (3), the greatest coincident peak is formed by 920 and 89 KW. occurring at 8 p. m. on Feb. 19, and the maximum peaks are as heretofore given. With this combination there is a saving in peak capacity of 15 KW., which leaves the diversity factor little different from unity, but amounts to about 15% of the peak output of the small plant.

When plant (3) is combined with plant (2) there is a saving in peak capacity of 51 KW. which amounts to 49% of the maximum load of the small plant.

Two large groups of towns, for which the aggregates of maximum peaks are about 10,000 KW., show the fol- lowing: One of the groups, which comprises towns hav- ing rather uniform characteristics, shows a diversity factor of something over 1.10, while the other group, in which the towns have diversified business characteristics, shows a diversity factor larger than 1.18.

All of the data I have available tend to show that diversity factor as between towns is highly variable and in some cases may be large, while in others it may be relatively small.

Considering the first illustration presented, the saving in peak capacity arising from a combination of the plants might not cover the additional generating plant necessary to supply a reasonable maximum transmission loss. This, however, would be influenced by the num- ber of power plants operated in the unified system, and their locations, as well as by the design of the trans- mission circuits.

In the case of the illustration of plants (2) and (3) and assuming that plant (2) is to be enlarged to supply both communities, with an accompanying abandonment of plant (3), there is then a saving in peak capacity of 51 KW. After allowing for the added generating plant required for the maximum loss in the transmission line to the smaller community, the saving in cost of equip- ment afforded by the diversity factor when making the enlargement of plant (2) amounts to between $5,000 and $7,500, which could be applied toward providing the transmission circuit. The power required for the small system could be generated at a low figure since about 50% of its load would go to improve the load factor of the unified system without increasing the maximum load.

Referring to the last illustration mentioned above, there would be a saving in plant capacity, on account of diversity factor, of over 1,800 KW., which, expressed in terms of investment, would amount to, say, $250,000. This can be considered as off-setting plant made neces- sary by a transmission system, since plant released from peak-load service in a growing system stands in lieu of additions to capacity to take care of new busi- ness.

IMPROVED LOAD FACTOR.—Improved load factor ac- companies increased diversity factor since increase of the latter decreases the peak load without changing the average load. Referring to the next to the last il- lustration of diversity factor heretofore given, the weighted average of the annual load factors of the sev- eral towns may be taken as 22%. Since the diversity factor between the towns is 1.10 the load factor for all of the towns served together will be 24.2%, while if the diversity factor had been 1.18 as is the case in the suc- ceeding example, the load factor would become 26%. Thus for unified electric systems there is a saving in op- erating cost per KW.-hr. owing to improved load factor as well as on account of the improved operating econo- mies of larger generating plants.

The reduction of labor costs and the economy in con- sumption of fuel and supplies per unit of output for well considered large plants compared with small plants, is sufficiently recognized to make it unnecessary to con- sider instances here.

RELATIVE INVESTMENT PER UNIT CAPACITY.—The installation costs per kilowatt of electric generating plants are dependent upon so many variables, such as ac- cessibility of location, character of foundations required, cost of land, quality of plant, labor-saving devices in- stalled, and efficiency, that it is not practicable to show specific relations between costs for larger plants as com- pared with smaller, but it is undoubtedly safe to say, in general, that the first cost of plant shows an advantage in favor of larger stations. In considering the investment in generating plants associated with unified electric sys- tems, a disturbing factor enters in the form of power plants that must be discarded when local central station systems become absorbed in consolidated systems. But commonly such plants are absorbed into the more com- prehensive systems on account of their inability to pro- vide adequate service at low cost, so that the transmis- sion companies often have sufficient leeway in the matter of rates to enable them to care for plant abandoned on these grounds.

The development of steam turbine generating units has an important bearing upon this matter. Some of the larger turbine stations have been built for less than $80 per kilowatt of rated output including all buildings, equipment and lands; and a detailed estimate for a very large plant has recently indicated that the total invest- ment may go below $70 per kilowatt of rated capacity when suitable and well-located land of relatively low price is available for the station. These figures are to be compared with the usual costs of the older types of stations which have been from $110 to $170 per kilowatt of rated capacity. These improvements have come about with the advent of the steam turbo-generating unit as a commercial machine, but other forces have also played a part in the result.

SPARE EQUIPMENT.—In general, as generating plants increase in size, or as two or more are brought into parallel operation, the percentage of spare capacity re- quired to provide thoroughly reliable operation decreases, since one spare unit having a capacity equal to that which is eliminated by the disabling of any one of the generating units is sufficient either for one plant or for a combination of plants of ordinary capacities.

GENERAL MANAGEMENT COSTS.—The aggregates of salaries of officers, other general salaries including directors' allowances, and general office expenses for all of the electric companies of the Commonwealth of Massachusetts, as shown by the 1909 report of the Board of Gas and Electric Light Commissioners, are as follows:

Salaries of officers	$234,853.03
Other general salaries, including directors' allowances	496,772.81
General Office expenses	307,443.54
	$1,039,069.38

In the general office expenses are included advertising, canvassing and engineering expenses.

The total expenses of operation, including taxes, legal expenses, insurance, bad debts, etc., for these com- panies aggregate, $6,279,046.26.

These figures show an average ratio of management expenses to total operating expenses for the electric companies in the Commonwealth of Massachusetts amounting to 16.5%.

The ratio for larger electric companies may in some cases be less than for smaller companies, but in general the ratio seems to tend toward an increase as the com- panies become larger and more comprehensive. This is not surprising, since when companies reach large pro- portions it is possible for them to obtain the benefit of the services of technical and commercial men of the broadest and highest ability as their general officers, and to have a trained specialist at the head of each of their important departments. Thus a most efficient or- ganization is obtained, composed of very capable men each having a single primary function in the organi- zation as against the necessity existing in smaller com- panies of having one man directly responsible for many or all of the functions of the organization. By having such effective supervision of each department, the added costs are compensated for, since the larger companies are enabled to make material savings by elimination of mistakes in general policies and in construction costs, and through taking advantage of all possibilities for re- duction in operating costs by use of the most economi- cal methods.

RURAL AND SUBURBAN SERVICE.—I have included, as one of the advantages obtained by consolidated and unified electric systems covering large territories, the ability to provide rural and suburban service that could not be profitably developed by local central stations. How large a factor this may become is difficult to pre- dict, but that it is well worth careful consideration can not be doubted. While such service will provide valu- able load, it will also place a company in position to give more comprehensive service, which should raise its standing in the estimation of the public.

When electric companies were originally organized, the product they had for sale was a luxury, consequently they were under little or no obligation to the general public. But electric lighting and power quickly became indispensable, and to-day if electric supply were dis- continued it would seriously affect both the business and the recreations of all civilized countries. On this ac- count, economists argue, responsibility now rests upon those providing electric service to manage their prop- erties so that they will sustain an appropriate part in the affairs of business and recreation as well as earn satisfactory returns for the security holders. This in- volves the planning and operating of electric plants so that they may economically serve all who will be bene-

fitted; and if the argument of economists is finally sustained by the judicial sense of the people, these plants will come into relations similar to those of common carriers, and must then serve all comers within reach, whether urban or rural.

Regardless of how small the fixed population of a community may be, an extended electric system which enters the territory is in position to provide service to consumers whether large or small. There are many instances where large power users are far from being practicable customers of small central stations, but which may be quite satisfactory customers of a comprehensive system. Some of these are purely summer users, such as stone quarries, stone crushing plants, and pumping plants for irrigation purposes; while in many cases mills and factories, whose power requirements are too great to be economically and reliably served from a local central station of ordinary capacity, may be admirably and profitably served by comprehensive transmission systems. It is likely that rural service will prove to be largely an off peak load since the power demand of an ordinary farm usually ceases at dusk.

Probably one of the most important advantages which a strong, unified and comprehensive electric system possesses over a number of small separate supply companies serving a territory, lies in its ability to serve profitably consumers which the smaller companies are unable to serve. The advantages of the company with extended power lines are emphasized through the improvement of load factor which may be accomplished when the requirements of several cities affording good winter loads are associated with the power loads of industries which operate only in the summer.

The foregoing illustrations and arguments show that there are many elements tending to make the serving of large territories from unified electric systems an economic advantage; but it should be clearly borne in mind that success of such systems must depend upon making the advantages obtained offset the losses occasioned by the transmission circuits and apparatus, the cost of their upkeep, and the appropriate charges to depreciation and for extraordinary costs, together with a reasonable return on the added investment involved.

An illustration of what may be accomplished by a comprehensive electric system supported by good engineering skill is found in the case of an eastern municipality comprising a scattered population of about 30,000 inhabitants which was served by a local central station. This town became a unit in the distribution system of a large unified steam-electric system, by purchase of the local plant, and a careful estimate showed that the aggregate sum that the customers would pay per year, under the new conditions for service of equal amount and quality, would be about 18% less than under rates required to net the purely local company a fair return on its investment after taking care of legitimate costs of operation. The service under the new conditions is manifestly of profit to the present supply company.

Weirs on Porous Foundations and with Pervious Floors.

By W. G. BLIGH,* M. Inst. C. E.

In a previous article in Engineering News† the author discussed the design of dams, barrages and weirs built on porous foundations. The types of structures described therein, with one exception, that of the Granite Reef Weir, were provided with an impervious horizontal masonry apron or floor, which receives the shock of the falling water, and in addition furnishes a greater part of the requisite length of travel for the percolating undercurrent. In addition to these there is a large class of diversion weirs which are

Fig. 1.

not provided with any impervious horizontal apron whatever, either fore or aft of the breast or drop wall, the weir body being formed mainly of pervious loose rock fill. Notwithstanding this apparently radical difference it will be found that the same principles are applicable to these cases as have been shown to govern the sections of weirs of the type described in the previous article, which will be termed Type A.

Before proceeding to take this weir type, termed Type C, into consideration, it will be well to add a few remarks on the case already alluded to, viz: one of a weir on a boulder foundation which is provided with a fore apron built of square blocks of masonry or concrete, spaces being purposely left between each block to allow of the passage of water between them. Fig. 1 represents the case in point, a drop wall which is overflowed and submerged in flood time and is provided with an impervious rear apron of clay and a fore apron of the isolated blocks of masonry. If the floor were solid and impervious the hydraulic gradient would be $A' D$ and on the other hand if it were perfectly pervious it would be $A' F$ and if non-existent $A' C$. A condition, however, exists intermediate to these extreme cases and, to use a familiar simile, this can be considered as analogous to the condition obtaining in a hose pipe which leaks through several holes, the water in which will spurt under

Fig. 2.

high pressure out of the first hole, and in a less degree out of the others until the hydrostatic pressure entirely vanishes. Applying this fact to this particular case, the hydraulic gradient in Fig. 1 will be a line $A\ G\ G'$ situated above the point F, the distance $F\ G$ representing the pressure at this point. For the remainder of its length $G\ G'$ the hydraulic gradient will not be one straight line, but a stepped parabolic curve.

The exact position of G is practically indeterminate, but as it is quite possible that the interstices left between the blocks could be stanched by the aggregation of particles of sand it is clear that part of the floor may be subject to a hydrostatic lifting pressure almost equivalent to that prevailing with the grade line $A' D$. The blocks will therefore have to be made thick enough to resist pressure, the effective weight of the drop wall being similarly affected.

As has been noticed before, the maximum hydrostatic pressure occurs when the head water is at weir crest, or at shutter crest level, if the latter are provided, while the channel below is empty. When the water over-tops the crest, the rise of the tail water will be much more rapid than that of the head water, thus reducing the difference of levels above and below the obstructing weir, i. e. the head, and with it the hydrostatic pressure.

Taking up now Type C, Fig. 2 represents a rectangular breast wall provided with sloping rear and fore aprons formed of loose rock fill. The former is clearly of no value until rendered stanch by natural silt deposit, which eventually will occur to a greater or less extent, but which cannot be relied upon to throw back the incidence of the water pressure as is done by an impervious rear apron of clay or masonry, consequently it must be left out of consideration.

Supposing the head water to be at crest level and the tail water at bed level, then the pressure of a heavy load of stone over the sandy bed beyond C will, notwithstanding its perviousness, present a considerable obstruction to the free passage of the water percolating underneath the breast wall, so much so that the water will rise in the interstices of the stone to some level B, and flow off on a slope. This rise is dependent on the extent of the obstruction caused. The hydraulic gradient will then be $A\ B$. The water in rising through the rock fill will bring particles of sand with it, thus undermining the apron and causing gradual settlement of the superincumbent mass until equilibrium is produced. The combi... and stone will then form a kind of nat... glomerate of very superior resisting p... either of its elements, if taken separat... will eventually become almost impervious... the settlement is made good by fresh st... whole mass, if properly protected from ... by heavy surface blocks packed close, ... come permanent. Experience has proved t... effective length of the apron, to ensure ... must equal c H, or the product of th... colation factor with the head of water. T... fective weight of the rock fill must also ... that of the hydrostatic pressure, other ... would be liable to disintegration. Thus in ... if the head be 10 ft. the weight of the r... per foot run must exceed that of 10 ft. o... With 50% voids, the specific gravity of st... ing is about 1.3. The thickness × specific ... is therefore 13 ft., which is about th... proportion. If the value were less, t... would have to be dredged out to aff... requisite extra depth required.

This process of settlement of the rock fill, which has to be made good afterwards, is clearly wasteful, and can be obviated almost entirely by the adoption of a series of impervious vertical obstructions in the shape of body or partition walls running parallel to the breast wall right through the mass of stone filling. The proper hydrostatic functions of these party walls were originally not understood and in the older weirs they were inserted more with the object of preventing disintegration of the surface from the erosive action of flood water, than from any regard to hydrostatic considerations.

An example of this construction is given in Fig. 3. The water percolating underneath the breast wall will rise up to the crest of the party wall at B, thence it will have to pass underneath this wall through the sand in order to reach the next partition and so on; the head is therefore practically divided up into a series of steps, so that the hydraulic gradient is likewise a stepped line; its mean slope must, however, not be less than the proper hydraulic gradient, or as i.e. We thus see that the conditions and requirements are practically identical with those obtaining in weirs of Type A, which have an impervious apron.

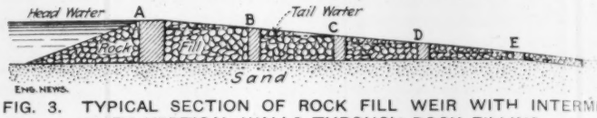


FIG. 3. TYPICAL SECTION OF ROCK FILL WEIR WITH INTERMEDIATE VERTICAL WALLS THROUGH ROCK FILLING.

A large number of rock-fill diversion weirs have been built in India for many years past. In these it was originally deemed essential to provide one or more curtain walls of undersunk blocks reaching down some 7 or 10 ft. into the sand to give stability to the structure and to prevent excessive leakage. These curtains added greatly to the cost of the weirs and now by the very bold successful experiment of Okhla Weir over the Jumna River it has been proved that these vertical curtains can be dispensed with altogether.

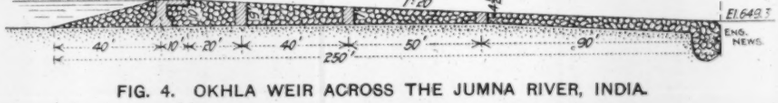


FIG. 4. OKHLA WEIR ACROSS THE JUMNA RIVER, INDIA.

A section of this remarkable work is given in Fig. 4. The effective base width, or value of l, in these weirs is not their extreme width, as the thin talus at the apex of the triangular prisms of rock filling cannot well be included as effective. In this case the head, or H, is 13 ft.; the percolation factor is the same as that of the Ganges at Narora Weir,* viz., 15, consequently l will be $13 \times 15 = 195$ ft. The fore slope is 210 ft. the rear slope 40 ft. wide; of this not more than 200 ft. would be effective. This weir has a unit

*44 Dupont St., Toronto, Ont.

†"Dams, Barrages and Weirs on Porous Foundations," by W. G. Bligh, M. Inst. C. E., Eng. News, Dec. 29, 1910, p. 708, Jan. 12, 1911, p. 52.

*Engineering News, Dec. 29, 1910, p. 710.

flood discharge of 140 sec.-ft. with an afflux of 3 ft., and as more than half the waterway is obstructed, it is consequently heavily strained. Nizamora Weir has a unit discharge of 75 sec.-ft. The other conditions being identical, according to the formula given in the former article,

$$L = 10\,c\sqrt{\frac{H_2}{10}}\,\sqrt{\frac{q}{75}}$$

the width of talus should be

$$L = 150 + \sqrt{\frac{10}{10}} \times \sqrt{\frac{140}{75}} = 206 \text{ ft.},$$

which practically corresponds with the actual [illegible].

[illegible] is another example of the Dehri Weir

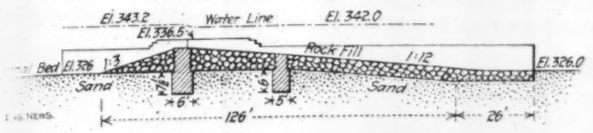


FIG. 5. DEHRI WEIR ACROSS THE SON RIVER, INDIA.

over the Son River in Bengal. The river sand has a percolation factor of 12. This weir is the longest on record, its length being 12,250 ft., nearly 2½ miles. The flood discharge being 830,000 sec.-ft. the unit discharge, or q will be

$$\frac{830{,}000}{12{,}250} = 64 \text{ sec.-ft. only, or less than one-third}$$

of that at Okhla. If remodeled according to modern principles it should be provided with a rear apron of puddle, with three party walls instead of one in the fore apron, the undersunk blocks could be abolished altogether, or else one line of concrete sheet piling substituted. This would effect a great saving in cost, as the curtains are five miles long.

Fig. 6, is the section of the Laguna Weir over the Colorado River.* The length of this weir is 4,000 ft., its section blocks the whole of the original waterway, but in spite of this the action on the weir is but slight, the unit discharge being estimated at 35 to 40 sec.-ft. only, which is extremely moderate. This section would, it is deemed, be improved by additional party walls, a clay rear apron and reduction in the width of the fore apron to 150 ft., the slope being flattened to 1 in 15. The continuance of the breast and party walls to deep bed level in the old deep water channel is not absolutely necessary. In several Indian weirs the deep water channel has been blocked at each end by rock fill and then filled up with sand; or else the channel is blocked by sheet piling, the current being diverted through the weir sluice channel which is first constructed. The party walls and the rock fill can then be founded on the sand fill. As a general rule the slope of the fore apron in this type of weir should be 1÷c, its continuation being horizontal.

*Eng. News, Feb. 27, 1908, p. 213.

In this case $c = 15$; the fore slope would thus be 1 in 15.

Fig. 7 is of the Madaya weir, in Burma, the design of which embodies modern principles. Its great width is due to the exceptionally high unit flood discharge which is 280 sec.-ft., the highest on record. The value of L by the formula

$$10\,c\sqrt{\frac{H_2}{10}}\,\sqrt{\frac{q}{75}}$$

taking c as 11, will be 234 ft., almost exactly corresponding with what it actually is, which, though a pure coincidence, is proof of the general accuracy of the results obtained. The weir bed is shingle and sand with a probable percolation factor of from 10 to 12. The width of this torrent being only 200 ft., a weir of Type *A* would clearly be more suitable in every respect and would cost less; particularly in maintenance.

The good points of Type *C* consist in the small amount of masonry required, all of which is above low water level, the rest of the work being done by unskilled labor. If a quarry of stone is available close by it may prove the most economical type. Its bad points are the increased action in the talus due to the raised fore slope. With a direct overfall as in Type *A*, depth is at once afforded to the current on passing the obstruction in which to churn up and lose its initial velocity, whereas in Type *C* the full depth is not reached until the termination of the apron. This causes increased action on the talus which during the first year after construction has to be renewed more or less every subsequent year until equilibrium is finally produced. The masses of rock which sink out of sight are not shown in the sections. In forming comparative estimates these annual renewals of material should be taken into account.

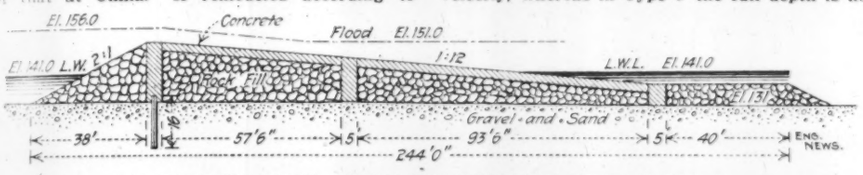


FIG. 6. LAGUNA WEIR ACROSS THE COLORADO RIVER, U. S. A.

There is an intermediate type (Type *B*) which in form is like Type *C*, but its sloping apron is solid impervious masonry. It has the disadvantages of Type *C* in similarly obstructing the waterway, but the rectangular sloping apron can be constructed entirely clear of water, resting partly on made sand. There is much less material than in Type *C*, and less masonry than in Type *A*. The hydrostatic pressure against the apron in this type is very much reduced owing to its raised position. An example is given in Fig. 8 of the Jamrao Weir, also on Indian work. This work is built entirely of brick masonry, stone or riprap not being procurable. The unit discharge over this weir is not known. The value of C is 15.

All of the more recently constructed Indian weirs are of this type.

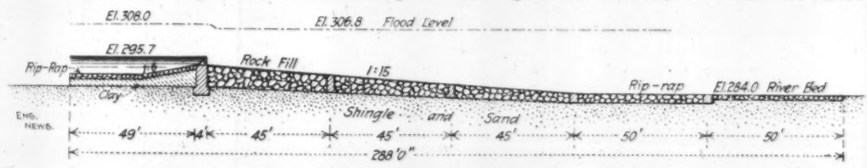


FIG. 7. MADAYA WEIR ACROSS THE MADAYA RIVER, BURMA.

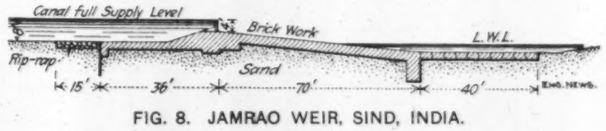


FIG. 8. JAMRAO WEIR, SIND, INDIA.

Approval of the Panama Canal Work by Members of the American Society of Civil Engineers.

High commendation of the Panama Canal work is expressed in the resolutions reprinted below, which were unanimously adopted by the party of members of the American Society of Civil Engineers who took part in the recent excursion to the Canal zone.

The resolutions were adopted at a meeting held at the Hotel Tivoli, Ancon, Canal Zone, March 15. The approval includes the design of the canal, the methods and equipment used and the personnel in charge. The endorsement given by the party of Members of the American Institute of Mining Engineers which visited Panama last fall was printed in Engineering News of Nov. 17, 1910, p. 549.

We, a party of Civil Engineers, Members of the American Society of Civil Engineers, having visited the Panama Canal at the cordial invitation of the President of the United States and the Secretary of War, desire to chronicle our impressions of this stupendous work now under construction, in order to show our appreciation to the President and the Secretary of War, and to give to the American people an idea of how the construction appears to men who have had experience in solving similar problems, although never on so large a scale.

We wish to express our gratification at the many evidences of energy, enthusiasm, and efficiency which mark the construction of this great engineering work, and to commend the economical handling and use of all labor and material.

The organization seems to be most complete and efficient, showing that the men chosen to conduct this great construction have proved equal to their task in the planning and execution of the work. By their example of loyalty, cooperation and devotion they have been able to establish an "esprit de corps" which prevails throughout the entire force, from the Chief Engineer to the common laborer, and results in the greatest measure of efficiency and economy.

And further, we wish to congratulate the Government that, in addition to the excellent engineering and construction forces above alluded to, it has been able to obtain as Chairman and Chief Engineer, Commissioners, and Secretary, men of such wise forethought and ability.

The plant and equipment seem most complete, not only as to quantity of machinery, but also in the wise selection of plant for each special piece of work. The problem of handling the excavated material, involving the constant moving of hundreds of trains daily in many directions, has been most effectively accomplished.

We were particularly impressed with the efficient methods by which the concrete is mixed and deposited in place having in mind the great problem of assembling the raw material from long distances, and the disposal of such enormous quantities, from 7,000 to 8,000 cu. yds. per day, at a cost which is, in our opinion, most reasonable.

The wisdom of the employment of Government forces for the direction of the work, and its execution by "day labor," has been fully justified by the results obtained, and is an ample guarantee that the work will be well done, and completed within the estimated time, Jan. 1, 1915.

The general design of the canal commends itself to our hearty approval, and the many details appear to have been worked out in a most thorough and skilful manner.

In our opinion, the creation, in the heart of Central America, of a typical American community, with all the best characteristics of American civilization, equal in health, social order and contentment to communities of similar size in the United States, and the conversion of unsanitary tropical cities into healthful places of abode, make the work the wonder of the century, and being of such fundamental importance to the success of this great enterprise, should prove to the American people the ability of the Government to handle properly any problem of a similar nature.

Finally, this party of engineers wishes to acknowledge most heartily, and in the fullest manner, the many courtesies it has received at the hands of the Members of the Commission and their employees, all of whom have given us every facility for investigation and full information regarding all obscure points.

Wm. H. Wiley, J. W. Rollins, Committee on Resolutions of the Civil Engineers' Party.

The above resolutions were presented at a meeting of the Engineers' party at the Hotel Tivoli, Ancon, Canal Zone, March 15, 1911, and were unanimously adopted.

George A. Kimball, Boston, Mass., Chairman; H. J. Burt, Denver, Colo., Secretary.

AUTOMATIC STOPS have been installed in connection with block signals on the San Francisco, Oakland & San Jose Consolidated Ry. The system covers a short stretch of double track 3½ miles in length, on which 576 trains per day are operated. The automatic stop used is said to be identical with that used on the New York Subway.

A Thermostat for the Control of Condensing Water.*

By B. VIOLA,† M. Am. Soc. M. E.

Condensers for vacuum pans, to which this paper is chiefly devoted, employ the wet system of condensation, in which the cooling surface is that of the cooling water during its progress through the condenser.

In practice it is often found that the injection of cooling water is unnecessarily increased at times by incorrect operation of the condensing plant. Beside other visible indications of this mistake the temperature of the condensed water shows it most strikingly. When too much water is used the work of the air pump is made more difficult because of the air liberated from the water and if the pump is accurately proportioned for normal operation it is unable to accomplish the extra work. If the pump is large enough, the work is accomplished, but at the expense of additional steam.

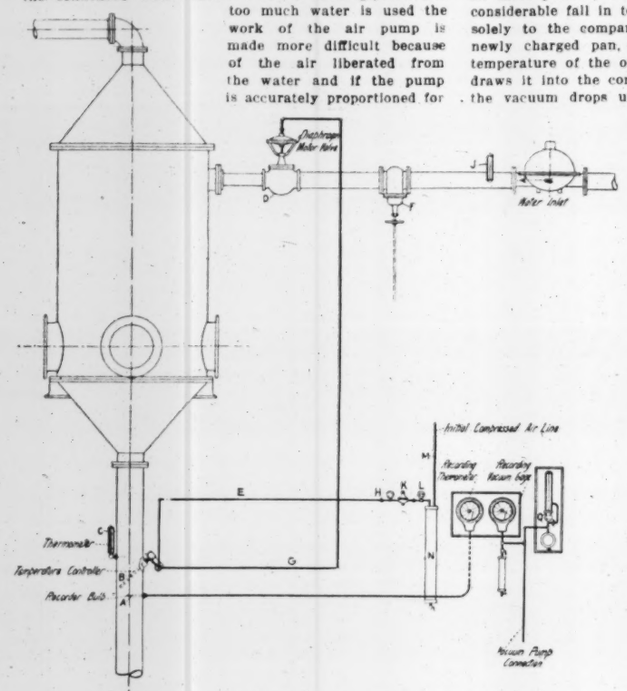


FIG. 1. DIAGRAM OF APPARATUS FOR THERMOSTATIC CONTROL OF CONDENSING WATER.

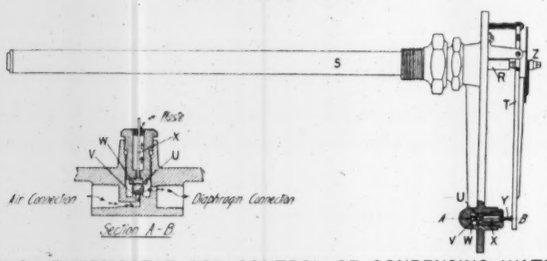


FIG. 2. THERMOSTAT FOR CONTROL OF CONDENSING WATER.

(This thermostat, when in use, is located in the tail pipe of the condenser, as shown at B in Fig. 1, and controls the supply of compressed air to the diaphragm-operated valve shown in Fig. 3.)

It is very important, therefore, that the right quantity of water be used to condense a certain quantity of steam. This matter is neglected in most condensing plants, but could be easily taken care of by using some kind of automatic device to regulate the flow of cooling water. Experience has shown that the amount of water should be from 20 to 40 times that of the steam to be condensed. This is a very wide limit and in large condensing plants where immense quantities of cooling water are required some controlling device should be applied so that water will not be wasted.

The description which follows is a record of experiments made and results achieved with a condensing plant used in connection with vacuum pans. A recording thermometer was first applied in the tail pipe of a concentric barometric condenser for the purpose of controlling the cooling water by hand operation of the inlet valve; but it was very difficult to convince the operator of the condenser that it was not necessary to let the cooling water run off cold, because it is generally believed the colder the water the higher the vacuum. After experimenting for some time it was found difficult to secure good results by hand regulation because of the continuous changes which must be made to meet conditions as the number of pans connected to the condenser is increased or decreased. This led to the application of an automatic temperature controller in the tail pipe connected to the compressed-air inlet valve, by which it was found possible to feed the condenser approximately in proportion to the steam or vapor which had to be condensed, resulting in a better average temperature of the condensed water and smaller variations.

By maintaining a fairly constant temperature of the condensed water, a nearly uniform vacuum was obtained except at periods when a new vacuum pan was charged. At these periods, the controlling thermometer showed a considerable fall in temperature of the outlet water, due solely to the comparatively cool air drawn in from a newly charged pan, which was filled with air at the temperature of the operating room. The vacuum pump draws it into the condenser, as a consequence of which the vacuum drops until all the air is drawn out and the new pan reaches an equilibrium with the vacuum which the pump is able to keep up in connection with the other pans. During this period of low vacuum, the water is shut off by the controlling thermometer and no cooling water whatever enters the condenser. Since the other pans are boiling, the temperature in the condenser increases until the water left in the condenser trays is raised to the temperature limit, when the controlling thermometer opens the inlet valve and the cooling water is again admitted.

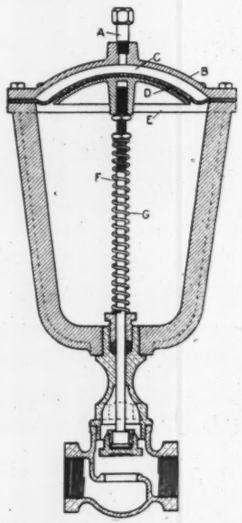


Fig. 3. Sectional View of Diaphragm-Operated Valve for Control of Condensing Water.

The construction of the controlling device is shown in Fig. 1. The stem *B* expands and contracts in response to temperature changes of the condensed water. The pipe *E* supplies compressed air of about 15 lbs. pressure to the valve mechanism of the controller, from which it passes through pipe *G* to the water-inlet valve, where it actuates a regular globe valve *D* by means of a diaphragm motor which replaces the ordinary hand wheel. The temperature of the condensed water affecting the stem of the controller permits all, a part, or none of the compressed air to pass to the diaphragm-motor valve and consequently the latter is very nearly closed, partly open, or wide open according to the conditions prevailing, allowing the proper flow of water to the condenser. Let us assume that the vapor pipe has been delivering an amount of vapor to the condenser which requires an amount of water that will flow through the inlet valve when the latter is exactly half open. Should more vapor enter the condenser the temperature of the water passing through the tail pipe would, of course, start to rise, but as soon as the controller stem was affected by this higher temperature it would expand and cause the valve mechanism of the controller to allow less air to flow to the water-inlet valve. Consequently this water valve would act to allow more water to pass through and thus maintain the proper proportion between the volumes of vapor and cooling water.

The auxiliaries are, *J*, a thermometer to indicate the temperature of the cooling water; *F*, a hand valve for emergency use; *C*, a thermometer to indicate the temperature of the water passing through the tail-pipe, serving as a check on the recording thermometer, which has its bulb at *A*; and *P*, a recording vacuum gage, checked by a mercurial absolute-pressure gage, *Q*. The initial supply of compressed air, *M*, which ultimately operates the diaphragm-motor valve on the water-inlet, enters the trap *N*, where any moisture or sediment is separated and which also acts as a storage reservoir. Gage *L* shows the initial pressure of the compressed-air supply, which is reduced by passing through reducing valve *K* to the pressure required for the controller, as shown by gage *H*.

Fig. 2 shows the very simple construction of the controller by means of a section through *A-B*. The stem is in two parts, the outer brass tube and the inner rod. The latter is composed of a material which has an extremely low ratio of expansion and therefore remains of almost constant length, regardless of temperature, while the outer brass tube elongates or contracts in proportion to temperature changes. The tube and rod are so arranged that they are always in intimate though frictionless contact at the extreme end. *R* shows the extension of the inner non-expanding member, which remains fixed when the outer tube elongates and advances when the outer tube contracts.

The movement thus obtained at *R* is transmitted by the lever *T* to the valve mechanism shown in cross section. This is simply a three-port valve, shown more clearly in the section *A-B*, and all ports are controlled by the one ball *W*. The first port, *V*, is the inlet for the compressed air supply, another port connects with the line leading to the diaphragm-motor valve, the third port is the outlet for the air which has served its purpose by actuating the diaphragm-motor. The position of the ball *W* depends upon the stem *X*, which is in contact with the lever *T* at *Y*. When extension *R* moves outward due to the drop in temperature at *S*, the lever *T* is raised, and the stem *X* allows the ball *W* to leave port *V* where the compressed air enters. The air can then flow through the second port to the diaphragm-motor valve, which starts to close. If a higher temperature acts upon *S*, expanding the outer tube and turning extension *R* inward, lever *T* forces stem *X* against ball *W*. The latter then closes port *V*, shuts off the air supply, and also opens the third port so that the air can escape from the diaphragm motor. The diaphragm-motor valve consequently begins to open.

In actual practice, the diaphragm-motor valve is only completely closed or wide open if the conditions are such that the tendency is toward a sudden change in temperature. The controller is so sensitive that the diaphragm-motor valve is almost constantly in motion, letting in just a little more or a little less water as may be required to properly effect the condensation.

If it is desired to change the setting of the controller, to maintain a higher or a lower temperature, it is necessary simply to apply a key to the screw *Z*, Fig 2, and by turning it one way or the other require extension *R* to travel more or less before the controller operates.

Fig. 3 shows the diaphragm-motor valve in section. This valve has a regular globe body, with a seat and disk arranged in the usual manner, but with a sliding stem that is operated by the diaphragm motor. The compressed air enters chamber *C* at opening *A*. This chamber is composed of a cast-iron top *B* and a rubber bottom *D*, called the diaphragm. The air pressure forces the diaphragm downward and the saucer *E* thus forces the stem *F* downward while compressing the spring *G*. When the air pressure is relieved the spring opens the valve again.

This installation has been the means of saving about $400 monthly for over a year in the charges for city water which was formerly wasted. In a single surface condenser connected to a vacuum drier very good results have been obtained and the quantity of cooling water has been decreased from 35 to 50% over that required with hand regulation.

In sugar refineries, combined surface and spray condensers are usually employed. The vapor from the vacuum pan passes the surface condenser first for the reason that in case the vapor carries along some sugar particles, they will be condensed at that point and can be used. In this way nothing is lost. The remainder of the vapor passes to the spray condenser, is condensed and flows down the tail-pipe.

Condensers of this type require a considerable quantity of water and permit of great waste when no controlling device is employed. Even where salt water is used this waste should not be permitted because it increases materially the quantity of steam necessary for the operation of the pumps. In many cases where salt water is now used on account of the great quantity required, the use of a well-constructed counter-current condenser operated economically with a precise temperature controller may make possible the use of sweet water. This is a decided advantage where the condensed water can be used for boiler-feed purposes. I would not recommend its use in the same condition as when it flows from the tail pipe, in spite of the assertion that condensed water does not contain any impurities carried over from the source of the vapor. However, when this condensed water is passed through an efficient water-purifying plant, there is no doubt that it may safely be used for boiler feed.

*Abstract of a paper read before the American Society of Mechanical Engineers at the annual meeting in December, 1910.

†11 Bartlett St., Brooklyn, N. Y.

The West Side Freight Traffic Problem in New York City.

A freight railway is operated through the streets in a thickly-settled section along the west side of Manhattan Island, New York City, by the New York Central & Hudson River R. R. (Fig. 1). It serves numerous factories along its length and terminates in an unloading and distributing station, St. John's Park. The operation of this railway is so objectionable that efforts have been made continuously for many years to get rid of it. The agitation has been especially active during the past five years, and at the present moment the city authorities are engaged in steps toward an immediate solution of the problem. An engineering report recommending a definite solution is up for action before the Board of Estimate.

The New York Central's west-side tracks are intimately related not only to the local freight traffic situation in New York City but also to the water-front and shipping situation. A considerable number of Hudson River piers is used by the railways for freight transfer purposes. (see Fig. 1). All the railways which terminate on the New Jersey shore opposite New York handle their freight by lighters and car-floats to and from piers on the New York side, these piers being the ultimate freight-houses. The New York Central, also, in spite of its West Side rail route, handles much of its freight by car-floats and lighters, and employs half-a-dozen or more piers in freight-house service. As the demand for piers in marine service is great, and is constantly growing, schemes for railway freight handling which would render the railway use of piers unnecessary have long been regarded favorably. In any case, the problem of the West Side trackage requires to be considered in close connection with the general railway freight problem of New York City's Hudson River waterfront.

The dispatch and economy of lighterage and car-float service for handling the city's freight to and from the railways have long been recognized. It was said years ago that the waters of New York harbor are an ideal switching and classification yard. Yet the apparent cumbersomeness of the water service brought out numerous attempts to formulate a better system. A few of these are mentioned in the following, which is by no means a complete history.

RAIL CONNECTION BY HUDSON RIVER BRIDGE.—One of the earliest of the proposed schemes contemplated a great suspension bridge across the Hudson for both passenger and freight service of all roads having New Jersey terminals, and an elevated railway from the New York end of the bridge southerly along the Hudson waterfront, skirting the commercial and manufacturing districts and running along the piers to exchange freight with the shipping.

The bridge schemes are a quarter century old, and at present seem quite dead. The elevated-railway scheme, however, has survived as a separate idea.

WEST STREET ELEVATED RAILWAY.—A definite move for elevated construction was made about 1900. A company holding a charter for a Hudson River bridge at New York City sought a franchise in the State legislature for an elevated railway extending along West Street, the marginal way along the Hudson waterfront. While this franchise was alleged to be necessary to make the bridge project practicable, yet it would have been separable therefrom, and the elevated railway would very likely have been constructed as a separate undertaking, for freight or passenger service or both. Such a franchise appeared to have a large intrinsic value, and the people of the city were opposed to granting it without compensation, besides objecting generally to an elevated railway on West St. The franchise was not granted.

Many years before this, an elevated freight railway on the West Side had been proposed on different occasions by different parties, particularly in the 90's by a commission of engineers charged with studying the west-side-freight handling conditions. Their recommendation had not been well received, and railway officials had argued successfully against its practicability from an operating standpoint.

WEST STREET SUBWAY WITH LATERAL DISTRIBUTING SUBWAYS.—A project for a subway distributing system of novel character was put forward in 1908 by Mr. W. J. Wilgus, former Chief Engineer of the New York Central & Hudson River R. R. It was described at some length in our issue of Oct. 15, 1908, and that description may be referred to for some facts regarding the affected freight conditions and costs. Mr. Wilgus' scheme was for a system of *small* subways, 8½ × 8½ ft., directly below the street surface. The system comprised a belt along the Hudson waterfront from 60th St. yard to the Battery and thence north along the East River to the Harlem River; a gridiron of distributing laterals extending landward from the belt-line subway, with crossings made by inclines to avoid crossing tracks at grade; and a tunnel extension under the Hudson River to a transfer yard on the Hackensack meadows. All freight was to be transferred to and from the small subway cars in the meadows yard or in the New York Central's 60th St. yard, the subway cars handling it between these yards and the factories or freight stations in New York City.

This plan was backed by the Amsterdam Corporation, a company formed to promote its construction and to bring the railways together. However, it did not find sufficient favor to secure realization.

ELEVENTH AVE. SUBWAY.—The several proposals for a subway in 11th Ave. of sufficient size to take railway cars without transshipment, have all been planned solely for the use of the New York Central. A law passed in 1906 by the State legislature (Saxe law) required the New York Central to remove its tracks from the surface and construct a subway instead. This law was nullified by the courts, but it had the interesting result of eliciting a voluntary offer from the New York Central to build a freight subway in Eleventh Ave. from 59th St. south to 30th St. Unfortunately the railway company made this offer contingent on a grant of perpetual franchise for four additional tracks along the Hudson River along the full length of Manhattan Island north of the 60th St. yard. The offer was refused mainly for this reason.

TOMKINS' ELEVATED AND TERMINAL SCHEME.—Mr. Calvin Tomkins devoted much attention to New York City transportation questions some years ago when he was chairman of a committee of a local improvement organization known as the Municipal Art Society. In that capacity he prepared a number of monographs which were published by the Soceity, dealing with various phases of urban transportation. Naturally, then, when he was appointed Commissioner of Docks and Ferries at the beginning of 1910, he soon gave close attention to the West Side problem, primarily with the purpose of bettering the freight-handling conditions at the shipping piers and ameliorating the congestion of West Street. The outcome (see Fig. 2) was his reviving the West St. Elevated scheme, which he has elaborated and advocated in several pamphlet reports to the Mayor.

Important elements of the Tomkins scheme are, (1) a very extensive group of terminal houses and storage warehouses, to be located near the 30th St. yard, and (2) a car-float terminal near 30th St., which is to bring the railway cars from the New Jersey shore to the elevated and take outbound traffic in the opposite direction. From the transfer bridges of the car-float slips, tracks would curve south into West St. and run up an incline set in the middle of the elevated-railway structure, thereby reaching the tracks of the latter. On the elevated, cars would run either direct to the steamer piers (for transatlantic or coastwise freight), or to the large terminal warehouses whence the street distribution by trucking would be done. The elevated railway tracks would lead to the second floor of these warehouses, and the cars would discharge their freight either to the team platforms in the first story or to elevators which would lift it to the upper floors of the building for storage.

Mr. Tomkins proposed that the city should

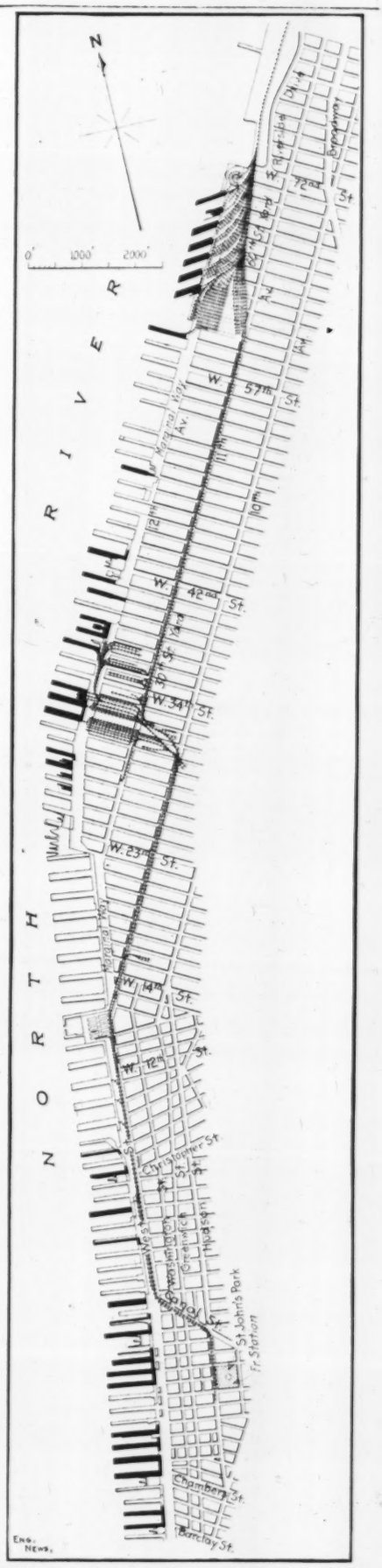


Fig. 1. Part of Hudson River Waterfront, New York.

(Showing existing freight tracks of New York Central & Hudson River R. R., and the railway occupation of the waterfront. Piers shown in black are owned or occupied by railways. There are 16 piers south of the lower limit of the map, and of these 12 are occupied by railways.)

build the elevated railway as well as the terminal stores, and should lease partial operating rights to any and all of the railways. An outlay of over $30,000,000 would be involved. His idea was that the system would put the railways of the New Jersey bank on an equal footing with the New York Central.

Neither city authorities nor railway officials have taken up this project warmly. The city objects to the great outlay required, when its available funds are badly needed for more urgent uses. The New Jersey railways apparently consider that their operating costs would be increased over the present, and that they would be put at a disadvantage to the New York Central, since the latter would save the car ferriage. The New York Central, on the other hand, looks forward to obtaining its own private elevated railway replacing its present surface tracks for the entire distance to St. John's Park.

LEGAL DISPUTE OVER ELEVENTH AVE TRACKS.—Before referring to the latest and most promising West Side project, it is necessary to refer to the fact that the New York Central's track rights in Eleventh Ave., Tenth Ave., West St., etc. (Fig. 1), are under a serious cloud. The state and city franchise grants under which these tracks are claimed to exist are badly confused. The city authorities have long maintained that the rights are now no longer in existence, being void by expiration of franchise. Court decisions have obstructed all attempts at summary proceedings on this contention, and a tedious suit over the entire question has been in progress for some years.

Aside from this, street occupation for which no legal rights are claimed is practiced by the railway company at various points along these tracks, by conducting loading and unloading operations, etc., in the streets. This is especially the case around the St. John's Park terminal station, which appears to depend for a large part of its service on use of the surrounding streets for other than train-moving purposes.

While it might appear off-hand that proper remedy for the appropriation of important thoroughfares could be found quickly by recourse to the courts, both the past court experiences and the influence of merchants to whom the freight service is a convenience are against any action unless based on a complete project containing a solution of the whole West Side problem.

The New York Central's claims relative to franchise rights appear to be responsible for its attitude on the elevated and subway schemes. An official of the company has stated that it is prepared to build an elevated freight railway all the way to St. John's Park, which action would maintain present conditions except for the operation of trains at street grade.

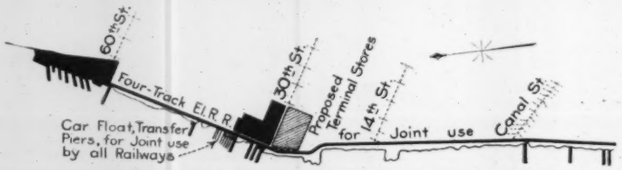


FIG. 2. SKETCH MAP OF PROPOSED WEST-STREET ELEVATED RAILWAY FROM 60TH ST. YARD TO FULTON ST. (TOMKINS' PROJECT).

(This project includes besides the elevated railway also (1) a large group of terminal and storage freight-houses between 25th and 30th Sts., 10th Ave. to West St.; (2) a freight classification and storage yard a little north of the New York Central's 30th St. yard; and (3) a series of car-float transfer slips between 36th and 40th Sts. These as well as the elevated railway, are to be built by the city and used jointly by all the railways under rental arrangement. One purpose of the project is to release from railway use all or most of the piers shown in black in Fig. 1, and to do away with the New York Central's surface tracks below 60th St.)

The "Unit Terminal" Plan.

The Board of Estimate and Apportionment of the city last June appointed three of its members a committee to consider means for ending the operation of trains on the streets by the New York Central in its west-side system. This committee delegated the study to three engineers: Mr. H. P. Nichols, Engineer-in-Charge, Division of Franchises, Board of Estimate and Apportionment; Mr. E. P. Goodrich, Consulting Engineer to the President of the Borough of Manhattan; and Mr. E. C. Moore. The engineering committee made a study continuing from last July until recently, and drew up a report which was submitted last week to the parent committee and with the latter's recommendation and approval to the Board of Estimate.

Messrs. Nichols and Goodrich agreed in their views, and prepared the report. Mr. Moore dissented, and favored the Tomkins elevated-railway plan, but the Board of Estimate committee rejected his views and adopted those of Nichols and Goodrich. This official report, which has good prospects of favorable action, contains wholly new proposals, sketched very briefly below.

TEMPORARY ABOLITION OF STREET TRACKS.—A study of the costs of operation of car-float and lighter service and of train operation over the New York Central's Eleventh Ave. and Tenth Ave. tracks, convinced the committee that the railway could discontinue general train service south of 60th St. yard and instead operate car-floats to the main distributing points without increased expense. At the same time the service would not be slower:

> Such operation would prove fully as expeditious as the surface operation now in use, because better running time is now maintained by the New York Central between its 60th St. yard and its pier terminals on Franklin, Desbrosses and Barclay Sts. than is made on the average to St. John's Park, and we believe that at no greater expense.

Such temporary arrangement is represented by the diagram Fig. 3. As the railway already has extensive car-transfer pier facilities at its 60th St. and 30th St. yards, no great amount of work would be needed to put the arrangement into effect. The local distributing trackage leading from the waterfront to St. John's Park, and to factories from Bethune St. to 16th St., as well as the 30th St. yard, would be maintained under this arrangement, pending the permanent solution; but the use of street tracks in Eleventh Ave., Tenth Ave. and West St. between these localities would be discontinued.

"UNIT TERMINALS," THE PERMANENT SOLUTION.—The economy and dispatch of car-float service is fundamental to the committee's conclusions, as regards a permanent solution as well. The committee recommends as the final system the entire abolition of train service below 30th St. yard, and the exclusive use of car-float service for this territory. Realizing that the use of piers as terminal freight-houses as at present is highly inefficient, besides occupying water-front space that is needed in steamship service, the committee sought for an improved terminal, and as such offers a novel pier-and-warehouse combination under the name "Unit Terminal."

Such a "unit terminal" is shown by the general plan Fig. 5. Essentially it is a device for (1) landing car-floats, (2) promptly transferring the cars away from the slip, so as to avoid blocking the car-float movements by car-unloading operations, and (3) unloading the cars at an inshore terminal station *inshore of the waterfront*, where trucking can be done much more conveniently than at the pier and where unlimited storage facilities can be provided as against the limited and awkward storage on piers.

In the sketch Fig. 5, the pier is fitted with two car-transfer bridges, which will give a safe margin of transfer capacity for any two railways. Switching tracks lead from the bridge back to the inshore end of the pier, accommodating an 8-car train and enabling it to be shifted over to the middle tracks of the outer half of the pier. From the later an incline extends to a bridge crossing West St. The cars are to be hauled up this incline and taken into the second story of a terminal house east of West St. The ground floor of this house is to be occupied by trucking platforms and truckways, while the upper stories can be developed to any height desired, for storage. The terminal house is not limited to one block width but can be continued eastward, the tracks crossing the streets on bridges.

The committee estimates that eight to ten such "unit terminals" located at intervals along the four-mile stretch south of 30th St. will meet all the needs of the case, and yet occupy less pier space than the railways take up at present, besides abolishing the objectionable railway operation on streets.

ELEVENTH AVE. SUBWAY.—The 60th St. and 30th St. yards of the New York Central & Hudson River R. R. are to be retained, the committee recommends. The surface operation in the streets between the two yards is highly objectionable, however, and the railway should be required to construct a subway. Fig. 4 indicates the location of this subway, and Fig. 6 shows an idealized view of such a subway and the commercial vicinage which it is expected to create. The subway is proposed to have six tracks, of which two might be used in the future (in connection with a two-track subway eastward through 50th St.) for carrying passenger trains to the Grand Central Station, whose present four-track tunnel approach (Park Ave.) is near the limit of its capacity.

RIVERSIDE TRACKAGE.—The disposition of the New York Central's tracks north of 60th St. yard did not seem a difficult matter to the committee. The only recommendation is that grade crossings be abolished by carrying east-and-west streets over the tracks except at the Manhattan Valley (in the neighborhood of 130th St.), where the railway is to be elevated.

The committee suggests also that the drawbridge over Spuyten Duyvil ship canal, just south of the junction of these tracks with the main line, is a sufficient obstruction to navigation that its replacement by a tunnel crossing should be contemplated.

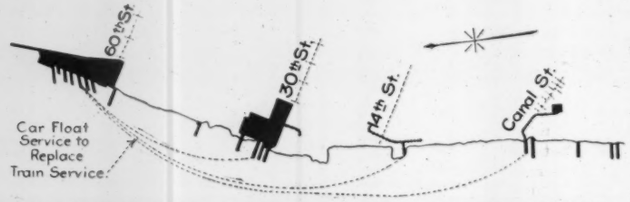


FIG. 3. SKETCH MAP SHOWING TEMPORARY TRACK-REMOVAL PLAN; CAR-FLOAT SERVICE REPLACING TRACK SERVICE BETWEEN YARDS AND LOCAL DISTRIBUTING CENTERS.

(Proposed by Nichols and Goodrich as a temporary expedient pending the provision of the permanent "unit-terminal" system.)

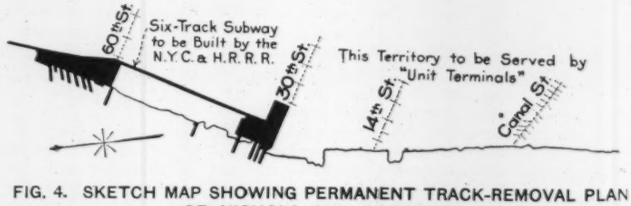


FIG. 4. SKETCH MAP SHOWING PERMANENT TRACK-REMOVAL PLAN OF NICHOLS AND GOODRICH.

(Six-track freight subway, like Fig. 6, connecting the 60th St. and 30th St. yards, to be built by the New York Central for its own use. The 30th St. yard is retained as a local freight-distributing point. All freight handling south of this yard is to be done by use of "Unit Terminals," provided at intervals between 30th St. and the Battery, to which cars are transferred by car-floats.)

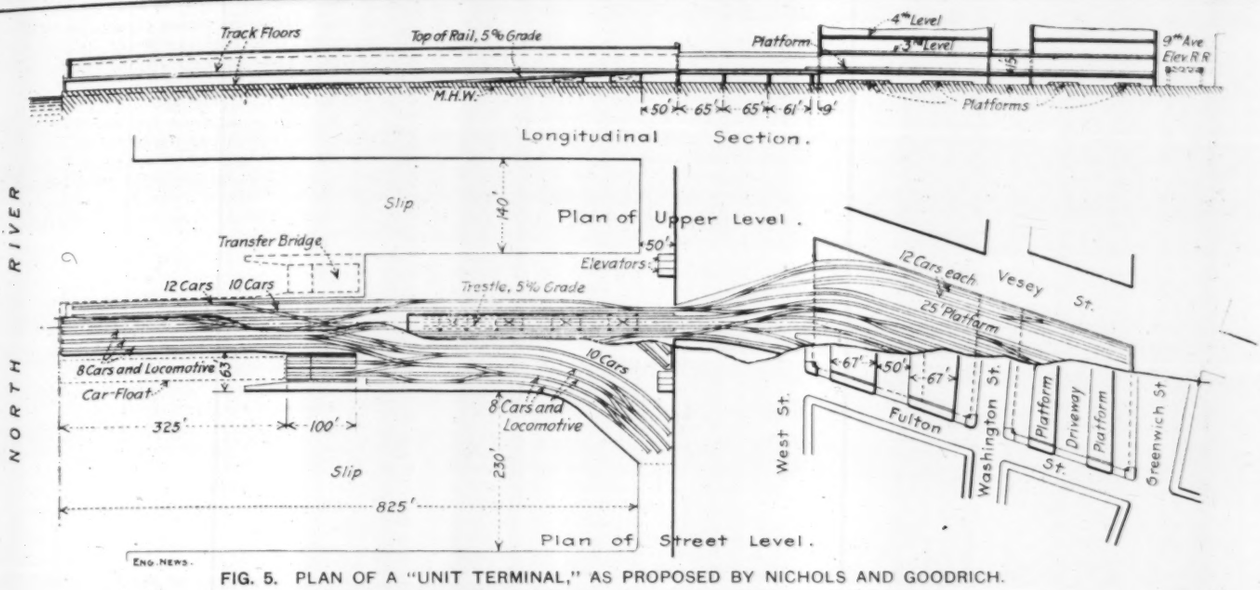


FIG. 5. PLAN OF A "UNIT TERMINAL," AS PROPOSED BY NICHOLS AND GOODRICH.

LONG STEAMSHIP PIERS.—Having in mind also the relation of the West Side tracks to the steamship piers, the committee points out that an elevated railway on West St. would obstruct any inshore extension of the slips, such as might be desired to accommodate longer steamers. The committee's plan, on the other hand, gives room for such extension particularly in the stretch between the 30th St. yard and 23d St. In this territory a set of four slips of lengths from 1,080 ft. to 1,500 ft. could be built without disturbing the street arrangement, Eleventh Ave., forming the marginal way along these slips, connecting direct with the existing marginal street along the Chelsea slips (12th to 23d Sts.).

CONSTRUCTION BY PRIVATE MONEY.—The committee's plan contemplates no outlay of public money. The "unit terminals" are to be built by the railways using them. This of course presupposes that they be willing to yield up their present pier leases and enter into the new scheme. The Eleventh Ave. subway of the New York Central is to be built by that company. Except for incidental expenses such as minor pier reconstruction, perhaps, the city would not have to spend any money to obtain the improvement, in which point the plan has a large advantage over the Tomkins elevated-railway project.

AN ARTICULATED LOCOMOTIVE of a novel design, known as the Garratt type, has been built in England for the Darjeeling-Himalayan Ry., of India. This is a 50-mile railway of 2-ft. gage, with a rise of 7,010 ft. in 47 miles. It has maximum grades of 2.7 to 3.5%, with several loops, and numerous curves of 70-ft. radius. The engine has no wheels beneath the boiler or firebox, but these parts are mounted on a girder frame, each end of which is carried by a steam truck. The smokebox end has a single bearing in the front truck, while the opposite end has two bearings on the rear truck, thus forming a three-point suspension system. Each truck has four wheels and carries a water tank, while the rear tank has also a coal bunker. Another tank is hung beneath the boiler. The point of support on each truck is a little beyond the inner axle, instead of being midway between the axles. Both trucks use high-pressure steam. The principal dimensions are as follows:

Wheels (8), diameter	2 ft. 2 ins.
Wheelbase of each truck	4 ft. 3 ins.
Distance between truck centers	17 ft. 3 ins.
Wheelbase, total	24 ft. 6 ins.
Length over all	33 ft. 2 ins.
Weight	28 tons.
Cylinders (4)	11 × 14 ins.
Steam pressure	160 lbs.
Boiler, diameter	3 ft. 11 ins.
Firebox	49⅝ × 51 ins.
Tubes; No., 195; diameter	1⅝ ins.
Tubes, length	7 ft. 3¼ ins.
Heating surface; tubes	603 sq. ft.
Firebox	64 sq. ft.
Total	667 sq. ft.
Grate area	17½ sq. ft.
Water in tanks	1,000 gals.
Coal in bunker	2,240 lbs.
Tractive power per lb. of mean eff. press	130.2

THE TRAFFIC THROUGH THE SUEZ CANAL has grown from 486 vessels, with a total gross tonnage of 435,911 tons, in 1870 to 4,533 vessels with a gross tonnage of 23,054,901 tons in 1910. The toll charges in 1870, at the rate of 10 francs per net ton yielded an income of 5,159,327 francs (about $923,500) and in 1910 at the rate of 7.75 francs the income amounted to 127,251,233 francs (about $22,778,000). The rate was reduced to 7.25 francs at the beginning of the present year. In 1887 the canal was electrically lighted throughout its length (87 nautical miles), and vessels can make the passage at night without difficulty. By far the greatest part of total tonnage is under the British flag, the total in 1910 being roughly about 14½ millions of tons; the Germans come next with about 3½ millions. In 1870 no German ship used the canal.

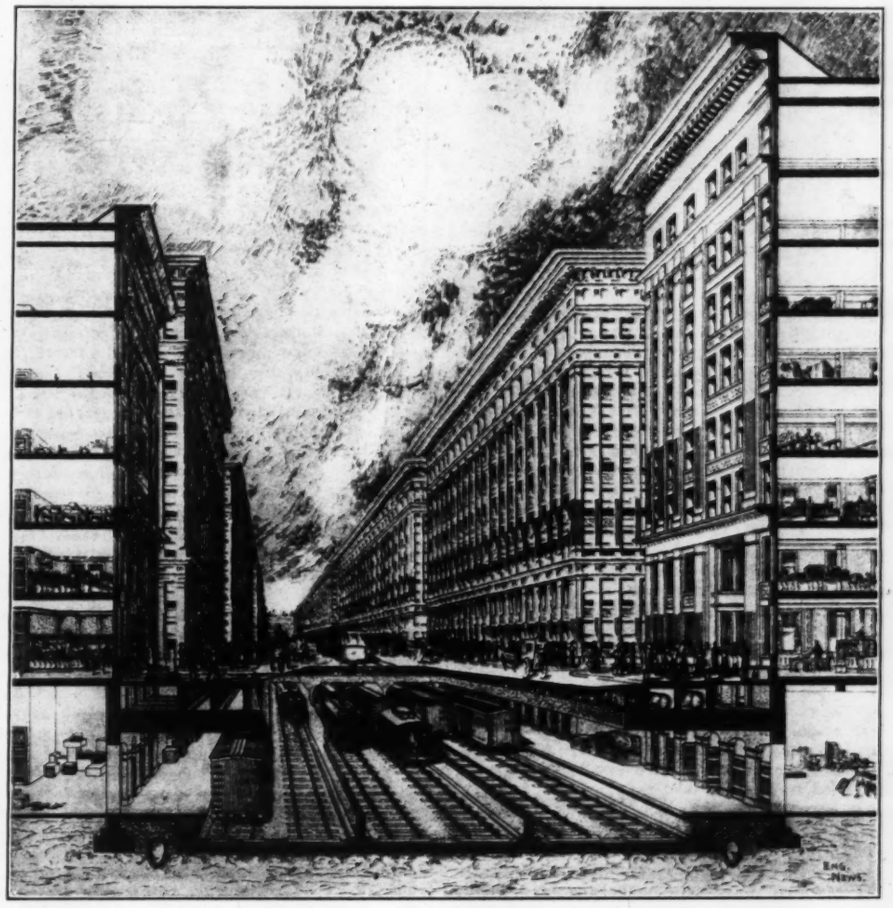


FIG. 6. PERSPECTIVE SKETCH OF PROPOSED SIX-TRACK FREIGHT SUBWAY IN ELEVENTH AVE. BETWEEN THE 60TH ST. AND 30TH ST. YARDS.

(The two middle tracks can be used for a passenger route to Grand Central Station. The next two tracks are freight running tracks and the two outer tracks are sidings. The construction of platforms alongside is expected to draw to this street manufacturing and trading establishments as indicated by the buildings in the sketch, which do not now exist.)

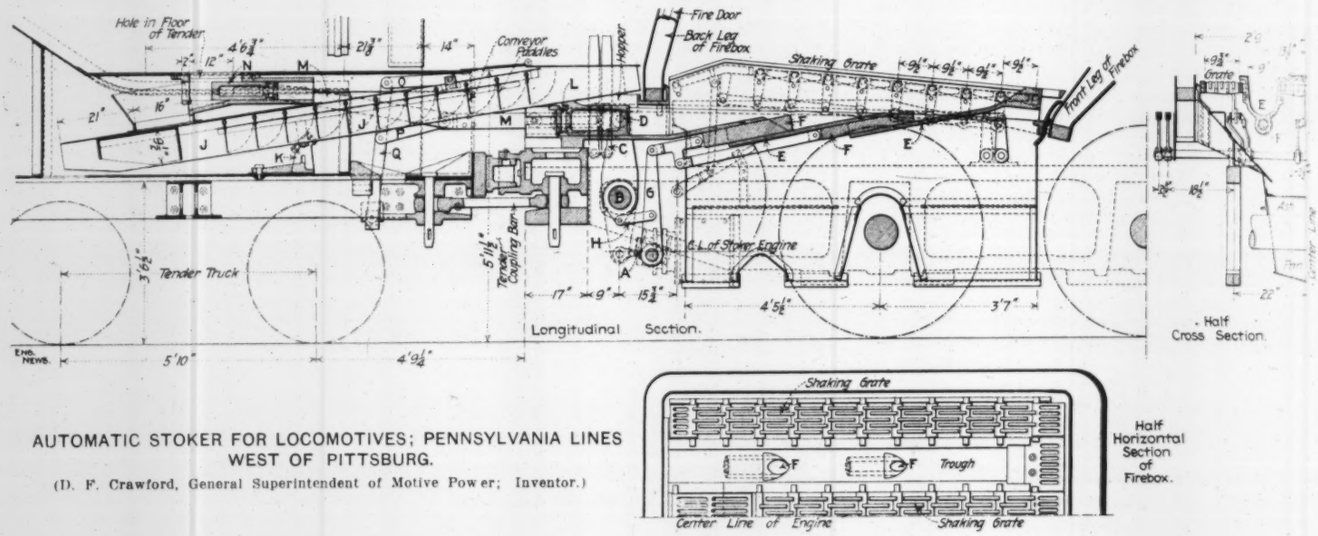
Mechanical Stokers for Locomotives: Pennsylvania Lines.*

The Pennsylvania Lines West of Pittsburg, after having tried several mechanical stokers for locomotives, took up the problem of a design which would satisfactorily meet their requirements. Mr. D. F. Crawford, General Superintendent of Motive Power, undertook to develop such a machine. It was considered that the machine should have the following features: (1) be capable of generating sufficient steam under all conditions of train, loading and speed; (2) it should burn the fuel in an efficient manner, and provide a material reduction in the smoke, as compared with hand-firing on the larger engines; (3) it should form a part of the locomotive itself and not be a temporary attachment; (4) no obstruction should be offered to the fireman in regard to access to the coal on the tender or to the firedoor for properly hand-firing the locomotive, either in combination with the stoker or with the stoker entirely inoperative; (5) the maintenance cost should be low and the device simple in operation, to avoid placing additional work upon the fireman in operating it.

The service trials of this stoker have been sufficiently satisfactory to warrant the more extended investigation of the subject for other classes of locomotives. It is the intention of the railway company, in order to obtain information as quickly as possible regarding the maintenance and service of the device in pool operation, to build 25 stokers which will be distributed over the various divisions, where varied conditions of service and fuel exist. The present machine is applied to a freight locomotive of the 2-8-0 type (Pennsylvania Ry. class H6b), the general dimensions of which are as follows:

Weight, working order	202,000 lbs.
Driving wheels	4 ft. 8 ins.
Cylinders	22 × 28 ins.
Valve gear	Walschaerts
Steam pressure	205 lbs.
Firebox, inside	66 × 107 ins.
Heating surface; tubes (exterior area)	2,677.0 sq. ft.
Firebox	166.5 sq. ft.
Total	2,843.5 sq. ft.
Grate area	49.0 sq. ft.
Tractive power (on 80% boiler pressure)	39,688 lbs.

The application of the stoker has not changed the general appearance of the locomotive. Close examination would reveal, on the left side of the locomotive, supported by the frame directly beneath the fireman's seat, a steam cylinder 15 ins. diameter and 12 ins. stroke. This operates the entire stoker and coal conveying mechanism. In the cab the only indication of the apparatus is by two small hoppers directly back of the boiler and extending about 4 ins. above the floor. These are used to supply coal to the stoker in case of failure of the conveying mechanism. It was desirable that all of the coal should be mechanically handled from the tender to the grate. The conveyor is so designed that it cannot only convey any grade of fuel, but can act also as a crusher if required.



AUTOMATIC STOKER FOR LOCOMOTIVES; PENNSYLVANIA LINES WEST OF PITTSBURG.

(D. F. Crawford, General Superintendent of Motive Power; Inventor.)

On the basis of these general principles, and in view of the successful evolution of the mechanical stoker in stationary service, it was thought that the underfeed principle would meet the requirements more nearly than any attempt to imitate the action of a fireman in supplying the fuel. It was thought, however, that to follow the design of successful underfeed stokers in stationary work would not give the required fuel-burning capacity, but that if the device could combine with it some means for rapidly and efficiently cleaning the fire this design offered the greatest opportunity for success. Early designs were laid out with some form of mechanical underfeed troughs which conveyed the coal into the firebox and distributed it onto the ordinary shaking grates. In this way ample provision was made for cleaning the fire, and, at the same time, the method of supplying oxygen for combustion was identical with that of the hand-fired locomotive, namely, through the grate bars.

In operation it was intended that the coal should be fed into the firebox below the grates, and then lifted and spread over the entire grate surface uniformly in order to provide a single continuous mass of coking and incandescent fuel.

The development of the present device has extended over a period of approximately six years, during which time there have been made eight different designs. These varied in the mechanical construction but followed the established principle of underfeeding the fuel, rather than scattering green coal over an incandescent bed of fuel. The design shown represents the progress which has been made up to the present time. It is covered by patents in this country, Canada, England and France.

*From information furnished by the Pennsylvania Railroad System.

The grate has two side sections 9¾ ins. wide and a center section 13 ins. wide. Standard grate shaking rigging is applied, so that either the front or rear half of the grate may be agitated while the other half remains stationary. In trough are two openings in which operate liary plungers or rams (F), of decreasing These assist in carrying the coal forward distributing it uniformly over the edge of trough upon the grates. The plungers are d from the shaft (B) by the arm (G) and the (H). This method of driving when taking power from the under side of the shaft pro a reversal of motion between plunger (D) (F), which reversal is desirable to efficiently tribute the coal.

The conveyor (J) which delivers the fuel the tender to the operating plungers (D) stoker is of the hinged-flap type, and from a feed hole in the floor of the tender hopper in which the plungers operate. A necessary to provide for the vertical and movement between the engine and tender a flexible support (K) for the conveyor This support is pivoted at two points, p for vertical and lateral movement, and pivoted joint is toward the rear end of conveyor, little movement takes place over hole in the floor of the tender. The forwar nd of the trough simply rests in proper guide on top of the hopper casting of the stoker; this readily takes care of the greater movement existing at the forward end of the conveyor trough.

Extending back from pin (L), and driven by a link on the outside of the two hopper castings, are connecting rods (M) coupled to a rectangular plunger (N) which operates under the hole in the tender floor. This plunger acts not only as an increment loader, but also as a crusher in properly loading the coal from the tender into the back end of the conveyor. The conveyor is driven from the connecting rod (M) by links (O) and (P) and the lever (Q). As the conveyor mechanism works to and fro, the series of suspended paddles scrape forward any coal which is discharged into the conveyor trough. These paddles are provided with stops to prevent them from swinging backward out of a vertical position, but they are entirely free to pass over the coal when moving on a backward stroke. The paddles are arranged in a number of sections in a row on each of the rods which support them. Thus, if they encounter a large lump of coal, only the paddle which is in contact with it is held up out of its vertical scraping position; in this way the efficiency of the paddles is not affected by irregularity in the size of the fuel.

No effort has been made to have the stoker engine operate automatically, as is generally the practice in stationary work. The reason for this is that the varying conditions prevailing in locomotive work do not permit of automatically meeting the sudden changes. It is, therefore, quite necessary that the fireman should use the same intelligence in anticipating the change of load conditions so far as the steam required is concerned as he does when hand-firing the loco-

motive. The operation is controlled by a globe valve located on the fireman's side of the cab, making it possible for him to sit and observe the signals at the same time that he is regulating the operation of the stoker.

For any reason the conveyor should become clogged, the stoker may be continued in service by feeding the fuel by hand through the doors into the cast-iron hoppers in which the main plungers (D). If a complete failure of the stoker machinery should take place, there is nothing to prevent the fireman from resorting to hand-firing. As the movement of all of the working parts of the machine is slow, never exceeding five strokes per minute, it is assumed that the wear and tear will be low, resulting in easy and cheap maintenance.

It has been demonstrated in service trial that while the stoker is handling the fuel or when hand firing is resorted to, the fuel will burn quite evenly over the entire grate surface, and trouble is only brought about when an even distribution of the fuel is not provided. It was at first felt that there might be some trouble with the formation of clinker upon the grate, but experience has indicated that there is a slight reduction in the amount of clinker as compared with the same fuel when hand fired. The construction is applicable to a firebox of any size. For a narrow firebox a single trough (of any length required) can be used; for a wide firebox, additional troughs may be used.

In preparing the stoker locomotive for a trip on the road the fire is built on the grates in the usual manner. After the fire is burning brightly the stoker may be started and kept in operation for the entire trip over the road. It has not been found necessary to resort to hand-firing even after the engine has been held a considerable time on sidings. The only labor required of the fireman is that of regulating the stoker, keeping the grates clean by shaking, and using the hook or scraper to spread the fuel over the firebox where, from any cause, thin spots develop in the fire. The locomotive equipped with this stoker has been in continuous heavy freight service for several months. The first trips were made between Columbus and Dennison, O., 100 miles; the machinery having been built and applied at the railway shops at Columbus. At the present time the locomotive is hauling full tonnage trains between Conway, Pa. (the Pittsburg freight terminal yard) and Crestline, O., 165 miles.

Daily reports to the Superintendent of Motive Power are made by an experienced observer. These give the train loading, the time on the road, the average steam pressure and speed, the number of times it is required to hook or spread the fuel over the firebox and shake the grates, the percentage of fuel handled by the stoker, the amount of smoke made, and any remarks of special interest. That the stoker has been relieving the fireman of the major portion of his work is indicated when it is stated that of 80 trips covering a distance of 7,350 miles, on only 18 of them the stoker failed to handle all of the fuel from one end of the run to the other; and on only three of these 18 trips was the amount automatically fired less than 90% of the total amount of fuel burned.

During the early trials it was evident that the underfeed principle of stoking would materially reduce the smoke without in any way decreasing the steaming capacity of the boiler. Close observation has been made of the amount of smoke emitted, as compared with the hand-fired locomotive in similar service. The results show that the greatest difference exists when the locomotives are being worked at their maximum capacity. As an example, on a double-head train Ringelmann chart readings indicated that the average smoke of the stoker-fired locomotive read 20% of the equivalent black chart, and that of the hand-fired locomotive read 60% for the same chart. When the locomotive is operating continuously along the road with regular tonnage it would be impossible to judge from the appearance of the smokestack that bituminous coal is being burned at a high rate per square foot of grate area, as it is practically smokeless. What smoke is made is but a very faint brown; it would require keen observation to discern its presence, and it could not be called a nuisance. When the grates are shaken or the hook is used to spread the fuel, about the same amount of smoke is given off as when doing the same with the hand-fired locomotive. Even at this time, however, the smoke produced lasts only from 5 to 20 secs.

This improved smoke condition, it is thought, has not only been brought about by the more gradual and efficient manner in which the stoker supplies the fuel to the fire, but also by the elimination of cold air passing into the firebox through the fire door. It is possible, with this construction, to keep the door closed almost entirely while the locomotive is in service. This is illustrated in one case where on a hand-fired locomotive, on a 100-mile run, covering 7 hrs. 15 mins., the door was open for a total of 1 hr. 10 mins.; using the stoker-fired engine on a run of 7 hrs. 50 mins., the door was opened a total of 6 mins. In neither case was the time included when the door was open on latch to prevent blowing off at the safety valve.

It has not been definitely determined that any economy in fuel has been effected by this design, but in view of the apparent better combustion it is expected that some economy will result. It is not thought that this will be equal to the best results which a skillful fireman can give, but that it will be equal to the performance of the average fireman when stoking a large locomotive with the attending fatigue of long runs.

By the reduction in manual labor offered by a device of this character more attention can be given by the fireman to proper feeding of the fuel, and in order to assist his observations peep holes are provided in the back head of the boiler to observe the action of the fire. In observing the fire through a colored glass the fireman has, at all times, a full knowledge of the condition of the fire in the box. This materially assists him in feeding only the required amount of coal for the conditions as they exist, and in caring for the emergencies which are at all times liable to occur. The officers of the railway company feel that the results thus far obtained have been sufficiently promising to warrant the experimental work necessary to make the machine satisfactory for all kinds and conditions of service.

A Light Timber Bulkhead.

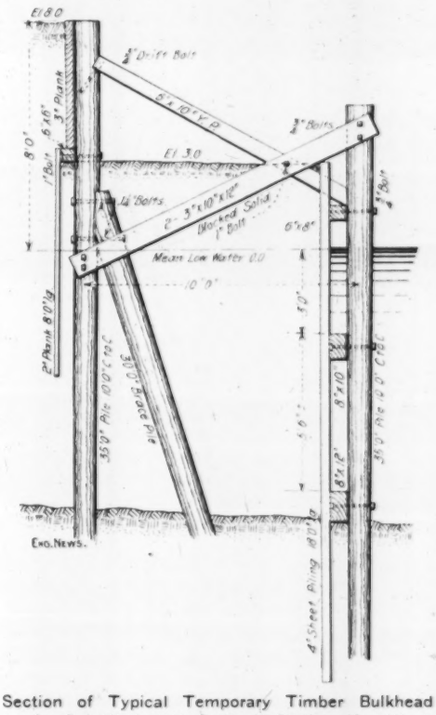
By DEWITT C. WEBB,* M. Am. Soc. C. E.

The accompanying sketch is a typical cross-section of a light timber bulkhead recently built at the U. S. Naval station, Key West, Fla., as a temporary retaining wall to hold back a hydraulic fill pending the construction of a permanent concrete seawall. These bulkheads were built some distance out from the then existing shore line in from 5 to 12 ft. of water and filled in behind by a hydraulic dredge, pumping in the mud which forms the bottom surface thereabouts. The section shown in the sketch is for the deepest water; where the water was shallower the lower line of longitudinal stringers along the outer row of piles was omitted and in the very shallow places a lighter section, without the sloping brace pile, was used. In all cases the fill had to be held to a height of about 8 ft. above mean low water.

The construction consists of an outer row of piles, spaced 10 ft. c. to c. braced back by a crossed-plank system to an inner row of piles, also 10 ft. c. to c., the latter row being braced by piles driven at a slant. The earth between the two rows is held, at an elevation of 3 ft. above low water, by sheet piling attached by stringers to the outer row of piles and the main fill is held at an elevation of 8 ft. above low water by sheathing similarly attached to the inner piles. All piles and lumber in the outer line of the bulkhead are of shortleaf pine treated with 20 lbs. of heavy creosote oil per cu. ft. The remainder of the lumber was of longleaf pine.

A line of 2-in. plank was placed in the lower part of the upper fill, behind the rear piles, to prevent the hydraulic fill from running underneath the back line of the bulkhead. During the progress of the work an attempt was made to omit this sheathing, but it was found to be absolutely necessary.

At the site of the bulkhead there was coral rock at from 20 to 25 ft. below low water and over this was silt and coral sand. The filling placed behind the bulkhead was silt and sand, some of it very liquid. As far as possible the best material was placed close to the bulkhead. The 2-in. inner sheathing was not driven until the fill had been placed to grade + 3. In order to observe any movement which might occur, a nail was placed in each bent on line and frequent observations made. At one point a movement of about 18 ins. developed very rapidly, the bulkhead evidently sliding out as a whole, since the piles remained vertical. Investigation of the record of pile driving showed that at this point the coral rock was very hard, rendering it impossible to drive piles into it more than a short distance.



Section of Typical Temporary Timber Bulkhead for Sea Wall at U. S. Naval Station, Key West, Fla.

Some additional anchorage was provided by pile butts buried in the fill about 30 ft. back of the bulkhead with old wire cables running to the tops of the back piles and there was no further trouble.

The reasons for the two levels of earth were, first, that it was not desired to carry the expensive creosoted timber any higher than necessary; second, it was felt that by placing the best of the material next the front line of the bulkhead and "stepping-off" the softer material above it the pressure on the sheet piling would be greatly relieved. The yellow-pine cross bracing between the two lines of piles acted as a truss to prevent the fill from pushing over the bulkhead. Its efficiency was demonstrated at the point noted above where, because of insufficient holding power of the piles in the coral rock, the bulkhead was pushed out, but the piles remained vertical, and the bracing showed evidence of severe stress. The matter of a passageway along the bulkhead was of no consequence as it was not intended to serve as a permanent structure.

*Civil Engineer, U. S. N., United States Navy Yard, Boston, Mass.

A MASONRY ARCH OF 230-FT. SPAN has recently been built to carry a highway into the town of Constantine, Algiers, across the Rummel River. The main arch is 70 m. (229.7 ft.) span and 25 m. (82 ft.) rise, and comprises two ribs each 4 m. (13.2 ft.) wide and spaced 4 m. (13.2 ft.) apart. The roadway, 8 m. (26.4 ft.) wide and the two sidewalks each 2 m. (6.6 ft.) wide are carried by spandrel walls on a reinforced-concrete floor slab system. The arch ribs are 1.5 m. (4.94 ft.) deep at the crown.

Krupp Balloon Artillery.

By F. P. MANN.*

Several types of special guns have been developed by the Fried. Krupp A. G., of Essen, Germany, for the attack of airships, especially balloons. Three types are shown in Figs. 1, 2 and 3. The maximum elevation of all these guns is made considerably greater than in ordinary types. As the object of attack moves very quickly, a high muzzle velocity of projectile is essential. Accordingly, the caliber of the gun and the weight of projectile are reduced. A long bore is also essential, the length in the types shown, being 35 times the caliber.

The first type shown is a 2.6-in. field gun. The wheels have pivoted axles so that they can be thrown into a position nearly at right angles to the gun carriage and be locked there. The rear of the carriage is pivoted to an anchor-plate which is sunk in the ground. Therefore the cannon can be rapidly swung in a circle about this anchor-plate as a center. Special attention has been given to providing for a rapid elevation of the barrel, it being mounted on trunnions near the breech. The sighting is done by special telescopes which form a telemeter. This carries engraved curves so that the gun may be rapidly aimed without the use of firing tables. The weight of gun proper in this type is 775 lbs.; carriage, 1,150 lbs.; total, 1,925 lbs. The projectile weighs 91 lbs. A muzzle velocity of 2,050 ft. per sec. is secured, and the maximum range is 28,300 ft. The maximum height is 18,800 ft. for an angle of 70°. This is shown on Fig. 4.

Some of the features of the first gun are embodied in the type shown in Fig. 2. This piece is of heavier build, however, and is designed for mounting on a motor car. The caliber is 3 ins. The gun carriage may be rotated about a central pivoted support through a complete circle. The elevation is secured as before by a toothed sector, and either rapid or slow motion may be employed. In the car shown, all the wheels are drivers so that the car is adapted for running over bad ground and up steep grades. It carries a 50-HP. motor and is rated to attain a maximum speed of 25 miles an hour. The weight of the car alone is 3½ tons. Under the front and rear seats are storage boxes with a capacity for 62 projectiles, besides tools and extra fittings for quick repair. To secure steady firing conditions, the car body may be clamped to the axles. The weight of the gun proper is 990 lbs., and of the support 1,550 lbs., which gives a total weight of 2,540 lbs. in excess of that of the motor car. A 12-lb. projectile is used with this gun, and a muzzle velocity of 2,060 ft. per sec. is secured. The maximum angle of elevation is 75°, which allows a maximum height of projectile of 20,000 ft. The maximum distance range is 30,000 ft. As shown in Fig. 4, these results are not greatly different from those with the field cannon above described.

A much heavier gun has been designed for use on shipboard, but embodying the general features of the two types already described. On shipboard it is not necessary to reduce the weight as much as for a field gun, and accordingly a larger caliber, 4.2 ins., is used. The weight of gun alone is 3,080 lbs.; while that of the support is 3,520 lbs., giving a total of 6,600 lbs. A 40-lb. projectile is used, and with the 75° maximum angle of elevation this may be thrown to a height of 37,620 ft. The maximum distance range is 44,500 ft. This type is intended to be mounted on torpedo boats and rapid cruisers, sh need develop.

For attack on airships, the question of t of projectile to be used is important Krupp concern has been engaged in exp during the development of this artiller cure the most effective ammunition. It found that for firing against balloons is not effective, for, though the balloon perforated by several bullets, such sm are apt to be closed, more or less, by inside sure. In such event, there is not a r

In the case of dirigible balloons with several independent gas bags, the chances are that some of these would be left untouched. It is believed that the best projectile is one which carries a sensitive contact exploder timed to explode inside the balloon and ignite the gas therein. It is necessary in this case, of course, to actually hit the mark, and to guide the gunners in correcting their aim the projectile carries a flaming fuse. In the daytime the trajectory is marked by a trail of smoke, and at night by one of fire. This effect is shown in Fig. 5.

Fig. 1. Field Type.

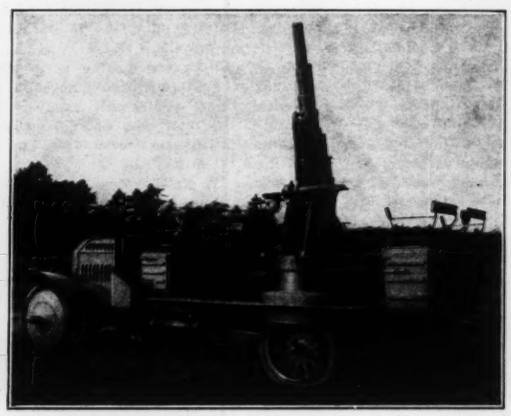


Fig. 2. Automobile Type.

Fig. 3. Naval Type.

FIGS. 1, 2 AND 3. KRUPP BALLOON GUNS.

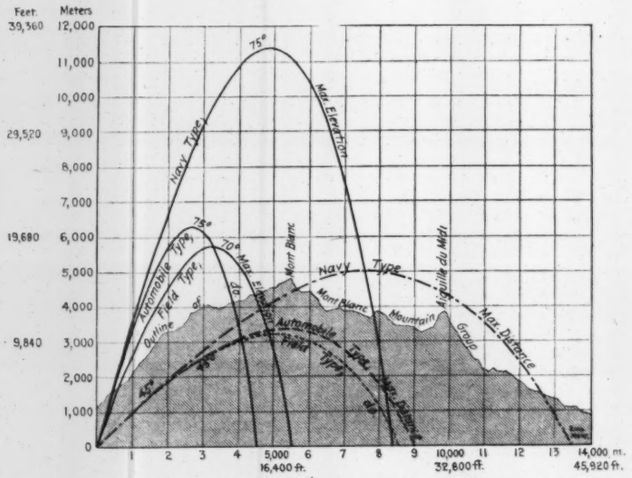


FIG. 4. TRAJECTORIES OF KRUPP BALLOON GUNS.

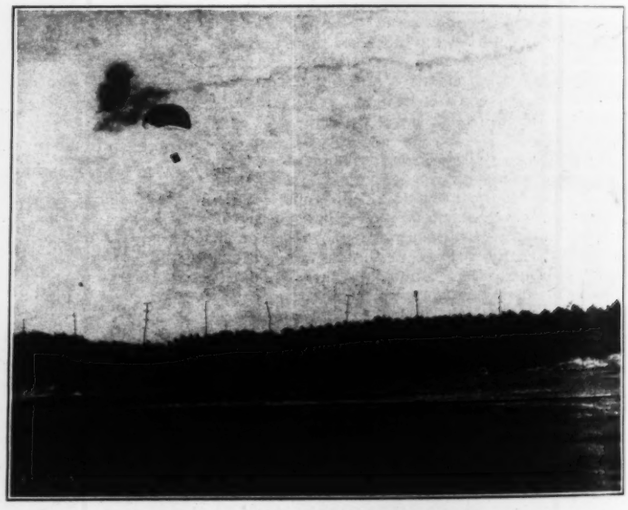


FIG. 5. DESTRUCTION OF BALLOON BY KRUPP PROJECTILE.

*136 rue d'Assas, Paris, France.

THE INCREASING USE OF ARTESIAN WELLS as a source of water supply is making a marked improvement in the health conditions in some parts of the Philippine Islands. According to the recently issued Special Report of the Secretary of War on the Philippines, 429 wells are already in operation. The dangers incident to drinking raw surface water is well known to all who have had experience in the Islands, and the people have come to appreciate this new source which furnishes a wholesome water without the former precautions of distilling or boiling. A number of experiments have failed to find any water at Iloilo on the Island of Panay.

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ADVERTISING

"Contract": Rates furnished on application.
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Copy for regular, or "Contract," Advertisements should be received at least ten days before publication; "For Sale" and "Situations Wanted" Advertisements by Monday, and "Proposal" and "Situations Open" Advertisements by 9 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

Eighteen years ago, as the result of what seemed at that time rapid growth and extension of the Engineering News Publishing Co.'s business, it became necessary to open a branch office in Chicago. Originally, this was occupied by one young man drafted from the Construction News Department at the main office in New York City; but a year or two later a member of the editorial staff was permanently stationed there.

The amount of work done and of business handled by this branch office has increased year by year until it has become necessary to have larger space to carry on the work. The offices on the 16th floor of the Monadnock Block, which have been occupied for so many years, therefore, have been given up and new offices of double the floor space have been rented on the 12th floor of the same building. The removal to the new offices will be made on May 1.

More than once we have called attention in these columns to the common practice which prevails in England of filling such municipal vacancies as those occurring in the office of Engineer or Surveyor and City Clerk from a list of candidates secured by public advertisement. German cities even go so far as to resort to advertisements for candidates to serve as mayors. We give below as an expression of the best British public opinion on this general subject an editorial note published in a recent issue of our London contemporary "The Surveyor and Municipal and County Engineer:"

Our attention has been directed to the method adopted recently by the Leighton Buzzard Urban District Council in filling the vacancy caused by the resignation of their surveyor. The appointment was not advertised, and one application only was considered by the council, who went into committee for the purpose. After considerable discussion the sole applicant was, by the casting vote of the chairman, appointed temporarily for a period of three months. As far as we are aware the division of opinion on the council was not as to the suitability of the candidate for the post—indeed he seems to have been well recommended—but strong exception was taken to the method of making the appointment in the committee and without public advertisement. Such a course of action naturally leads to suspicions in quarters where the full facts may not be known, and this, in our view, is quite sufficient to condemn it as unwise, to say the least. A local authority in making appointments must, like Caesar's wife, be above suspicion if public confidence is to be maintained, and we cordially trust that the procedure adopted in Leighton Buzzard will not be repeated nor copied in other quarters.

It will probably be a long time before American cities in general will secure their city engineers by public advertisement, but a change to that plan would not be considered nearly as radical now as it would have been only a few years ago. In fact, some recent American city charters distinctly provide that executive positions demanding of their incumbents technical training may be filled by men who are not residents of the city.

The New York State Barge Canal continues to lag behind its expected progress. A tabulated record of the state of the work on the numerous contracts at the end of 1910, in the February issue of the official publication of the canal administration, the "Barge Canal Bulletin," gives for each contract the percentage of the work accomplished up to January, 1911, and the percentage of work that should have been accomplished had the work proceeded uniformly from its inception to the date of its completion designated in the contract. Concerning the table, the "Bulletin" says:

Analyzing this table, it may be said that the work covered by 9 contracts has been finished, 4 contracts have been terminated for one reason or another and 10 contracts were let so recently that the requirement for beginning operations was not in force at the beginning of the year. Of the 58 remaining contracts, 5 are for structural steel work and are somewhat dependent on the completion of structures under other contracts for opportunity of progressing; 6 are ahead of the percentage that should be done; some 5 are very nearly equal to this percentage, and 3 or 4 others are not far behind. This leaves 38 contracts, or nearly half of the 81 let thus far, that are noticeably backward in progress.

Further analysis shows that the average progress on the 58 contracts now being prosecuted, should have been 60% of completion on the first of last January. The parallel column gives an actual average progress on these 58 contracts of 40%.

The delays in the preparation and letting of contracts on the canal have been notorious, but the canal authorities have carefully explained that they were largely due to the reluctance of contractors to bid. Hindrances of a changing political management, the restrictions on the amounts of bids, the severities of a Northern winter and the necessity for keeping open the old Erie Canal acted together to discourage sharp competition for any contract and resulted in frequent readvertising for bids. That period is now nearly past; all plans and designs are practically completed, and fully 90% of the work is under contract and has been under contract, as the above figures show, long enough so that the customary initial inertia should have been overcome. In spite of this, over half of the contracts are "noticeably backward in progress," and the average stage of all the contracts is at least 33% behind expectations. The condition is so general, and the extent of the delay is so marked, that the conclusion is unavoidable that neither the contractors who accepted the time limits nor the officials who set them sufficiently appreciated the various hindrances that operated so effectively to retard the making and letting of the contracts. Either this is the case, or else the general lassitude that seems to pervade some governmental work has extended over the entire body of contractors.

Engineers of the older generation, who recall the history of the famous Hoosac Tunnel in Massachusetts and the financial aid rendered in its construction by the state treasury, will be interested in the news that the State of Colorado proposes to embark in a railway tunnel enterprise. The Denver, Northwestern & Pacific Ry. was projected some years ago by the late David H. Moffat, to extend from Denver nearly due west, opening up a section of Colorado hitherto without railway facilities and giving a direct line from Denver to Salt Lake City. As described in out issue of March 9, 1905, this railway has been carried across the high mountain range west of Denver by means of a series of switchbacks and steep grades. In order to make the line practicable for trunk line use, it will be necessary to drive a four-mile tunnel through the base of James Peak, at an altitude of some 9,000 ft. The Moffat road has hitherto been unable to finance the construction of this tunnel. By a bill which has just passed the lower house of the Colorado Legislature, the state is to issue bonds to the amount of $4,000,000 to construction companies which undertake the work of building the tunnel. While rights to operate trains through the tunnel are to be open to all railway companies, it is recognized that the tunnel is really in the interest of the Moffat road and of whatever system it may eventually belong to.

The bill in its present form requires approval by a referendum vote at the election of 1912 before it will become operative. The general proposition of lending public credit to railway or other corporations is in so much disfavor at the present time, as a result of the unfortunate experience that attended such ventures 30 or 40 years ago, that it seems very doubtful whether the present project for state aid will be carried through.

An old, old abuse, with which most engineers and contractors have had experience, is the attempt of cities and companies to try to save money in letting contracts by scrimping on their engineering and compelling the contractor to either spend money for which he may get no return or else take the contract as a gambling risk. A typical example is described in the following letter:

Sir: In your issue of March 30, on p. 156 of the Construction News section, is an advertisement for a reinforced concrete highway bridge at Easton, Pa., which is typical of the injustice often meted out by County Commissioners and County Engineers to Contractors and Contracting Engineers.

The following statement is significant:

Specifications and general drawings are on file at the County Commissioners' Office and copy can be obtained from the Engineers upon deposit of $10. Each bidder will be required to file with his bid detailed plans conforming to all requirements, and shall show all sections, reinforcement, etc., and follow the general architectural treatment of the plans on file. The Commissioners reserve the right to reject any and all bids.

The time is coming, I hope, when Engineering Contractors will absolutely refuse to bid on such a proposition as this. To properly go into this matter and make proper investigation of the foundations, will cost anywhere from two hundred to five hundred dollars, and, in fact, if the strict letter of the advertisement were followed, the cost would probably be greater than the above figures. It is the handling of important engineering works in this way that cheapens the profession and makes many of the engineers of to-day feel that the profession should be put on a higher plane by licensing through State Boards.

I do not wish to go on record as an advocate of licensing, but I do wish to be recorded as absolutely against such an indefensible practice as shown in this advertisement. It opens the way to juggiery in the award of the contract, to say nothing of the wrong attitude in attempting to cheat the profession by obtaining free engineering service.

Yours very truly,

H. G. P.

Harrisburg, Pa., March 3, 1911.

The strange thing about it is that the aldermen and councilmen and mayors and other city officials who attempt to carry on public business in this way, actually delude themselves into the belief that they are economizing the tax-payers' money and showing evidence of their business ability. They do not understand, because of their crass ignorance, that it is a case of saving at the spigot and wasting at the bunghole.

They balk at the idea of paying $200, or $500 or $1,000 to their own engineers to have investigations made to show where the foundation rock lies, what the material is that must be excavated and, in general, what the work will actually involve in the way of cost. They say, "Why spend all this good money? Let the contractor spend it. Let him take it out of his profit." They have the prevalent idea that a contractor is a man who makes so much money from his public work that anything they can get out of him is so much clear gain.

But the most elemental knowledge of business principles ought to teach them that no competent and financially responsible contractor is going to undertake a gambling risk without charging enough in his bid to save himself from loss. Engineering News has always opposed the placing

of needless risk upon the contractor. The very idea of contract work is that the work can be planned and measured and estimated beforehand, so that contractors may know what is required of them and be able to fix with reasonable accuracy the cost of doing the work.

We are well aware that there are contractors who will take gambling risks of the sort our correspondent describes above, and will bid low on such work in order to get it; but such contractors in nine cases out of ten are either financially irresponsible or are shrewd and tricky enough to get even with the concern which tries to "do" them in this way. To let work to a contractor of this sort almost inevitably costs the city or county or other public body in the long run a good deal more than it does to let it to a competent and reliable contractor who understands his business.

It may also be remarked that the practice of letting contracts without advance engineering information on which to base the contracts has been responsible for more pooling and grafting in the contract business than any other one thing. Take the case of a bridge letting, where, as in this case, the county authorities are asking the bidders to spend a large amount of money before the bid is made in finding out what the work involves. What is more natural than that the bidders should combine together and pool the expense of having some sort of survey made to determine where the foundations must be placed and what the material is overlying them? It is but a step from this to an arrangement among themselves as to who shall submit the low bid and what division shall be made of the profits.

All reputable contractors appreciate the injury that is done to the contracting business by such methods of contract letting. It is much better for contractors as a whole that work in which the risk cannot be fairly ascertained in advance shall be done by days work. Contract work ought to be confined to work which involves quantities and conditions that can be fairly well determined in advance, and such determination by competent engineers should never be omitted.

Further Results of "Research" in Steam Boiler Engineering.

About two years ago, in our issue of March 11, 1909, we called attention to the fearful and wonderful formula for heat transmission in steam boilers evolved by Prof. John T. Nicolson, of the University of Manchester. To save space, we refrain from printing again here the formula of ten terms and as many variables which Prof. Nicolson then bestowed upon the engineering world and turn our attention at once to the idea which lay beneath the formula.

This idea, reduced to terms understandable by ordinary men, is that in order to evaporate water very rapidly in a boiler, the hot furnace gases must be made to flow along the heating surface very rapidly. Expressed in quasi-mathematical terms, the amount of heat transmitted through boiler heating surface is almost directly proportional to the speed of the hot gases over the surface. Hence, said Prof. Nicolson, it follows mathematically that the area of heating surface in a steam boiler of given capacity might be reduced "to one-half or one-quarter or even one-tenth of what is now used," simply by making the hot gases travel over it twice or four times or ten times as fast.

Now we have no quarrel whatever with this conclusion—as a mathematical conclusion. But as a conclusion practically applicable to boiler design without taking into consideration numerous other practical conditions, it seemed to us the height of absurdity, and we so indicated in our editorial of two years ago.

It appears, however, that Prof. Nicolson has had the courage of his convictions and of his mathematics. He has actually undertaken to apply his ten-term formula and the basic idea underlying it to the design and operation of real steam boilers. That his formula does not take into account the obstructions to heat transmission due to ash or soot or rust on the fire side of the heating surface or scale on the water side; that it ignores the behavior of boiler plates and fire-brick when subjected to excessive temperatures, the difficulties in keeping water in contact with the surface of a plate at high rates of evaporation, and the idiosyncrasies of draft fans exhausting hot flue gases at a draft pressure represented by 10 to 20 ins. of water—all these things appear to be as fine dust in the balance to Prof. Nicolson, as he proceeds to show the world how to design boilers on true scientific principles.

Our British contemporary, "The Engineer," in a recent issue has so admirably summarized and commented upon Prof. Nicolson's recent work that we reprint below the substance of its editorial:

THE REFORMATION OF BOILER ENGINEERING.

We admire Dr. Nicolson for the persistence with which he attempts to reform boiler engineering. He holds that the practice of making steam as now followed is antiquated and inept. He is prepared to show the world a more excellent way; and failure and rebuffs leave him undaunted.

It may be easily conceded that Dr. Nicolson is a very excellent example of the results of the highest type of technical education; and it is well worth while to study his methods of dealing with the usual problems of boiler engineering. For him the transmission of heat, the combustion of fuel, the manufacture of steam, are simply matters of mathematical investigation. Each question as it turns up is solved by an equation; and we have statements put forward as demonstrable truths which are enough to make the hair of common boiler designers, makers, or steam users stand on end. Quite recently we dealt with Mr. Longridge's report on a Nicolson experimental boiler. It will be remembered that that report would have proved very disheartening to anyone who had not a fair proportion of faith in himself. Dr. Nicolson, however, has been equal to the occasion. He has apparently abandoned the attempt to make the Cornish or Lancashire boiler better, and has produced a new design which he has made the subject of a very clever paper read before the Institution of Engineers and Shipbuilders in Scotland recently. The subject is "Boiler Economics and the Use of High Gas Speeds."

The history of Professor Nicolson's labors is quite simple. He became acquainted with a statement made by Professor Osborne Reynolds as far back as 1874, to the effect that the amount of heat transferred from hot air to a metal surface is almost in direct proportion to the difference of their temperatures and to the product of the speed of movement and density of the air. To Professor Nicolson this means that if we pass the same weight of gas through a tube at different velocities, the rate of evaporation will augment with the velocities. He says, then, in effect, instead of letting the flame and products of combustion roll languidly through the great flues of a Cornish or Lancashire boiler, compel them to move at a high velocity. This can only be done by contracting the calorimeter of the boiler—that is to say, reducing the cross-sectional area of the flues. But if this is done the friction will be so great that air enough will not get to the fires. Use, then, an exhaust fan, and make a vacuum at the root of the chimney of 15 ins. to 20 ins. of water, and the thing is complete.

Furthermore, as we shall not now want a high, or, indeed, any particular chimney temperature, let us combine with the boiler an economizer; and if high speed is good for the former, so it must be good for the latter. Contract, then, the calorimeter of the heater, because the fan will deal with the resistance, and employ a good big circulating pump to keep the water going at high speed through very small and long tubes.

It will be remembered that in the first experimental boiler a water drum was put into the flue of a Cornish boiler, which was of so nearly the same diameter that only 1 in. of space intervened all round. Through this space the products of combustion had to find their way under the influence of a fan. Unfortunately, this was too much for the drum, which was speedily burned, and then Dr. Nicolson substituted the long fire-brick cylinder, which was in the boiler when Mr. Longridge carried out his tests. Mr. Longridge held that the theory of the boiler was admirable; its practice execrable. For one thing, every time the boiler was inspected the fire-brick drum would have to be pulled out.

We now learn from the paper before us that Dr. Nicolson has abandoned the Cornish boiler, as we have said, and has designed a new mechanism for generating steam. To call it a boiler would be perhaps profanation.

We hasten to say that this generator is extremely ingenious. That it complies very fully with scientific indications of what a boiler should be, in the sense that it is intended to absorb the largest possible quantity of heat in any unit of time, per sq. ft. of surface, there is no room to doubt. But, when we have got thus far, it seems to us that we have reached a limit.

The proportions of the Nicolson generator, its economizer, fan, etc., and the results to be obtained, have all been settled by elaborate formulae, over 22 in number. These, however, depend for their utility on [illegible] coincidence with facts. Thus, if surfaces become [illegible] the rate of evaporation may be diminished, and [illegible]

But leaving this to be settled in a few [illegible] months, or perhaps days, let us proceed to consider the new boiler is like. The description comes in VI. of the paper, under the head "Rational Des[illegible] Steam Boilers." Hitherto apparently the designs [illegible] been irrational. The author now proceeds to show "by the application of Stefan-Boltzmann's law of [illegible] tion, and Osborne Reynold's law of heat transm[illegible] the designing of a steam boiler may be rationally [illegible] ried out, with the assured expectation that the [illegible] actually obtained on trial will be in close accord [illegible] with those predetermined by calculation."

We may remark incidentally that Dr. Nicolson [illegible] seem to be aware of the fact that the laws of rad[illegible] by hot gases are just now in the melting pot, and without the least knowledge of either Boltzmann or Stefan, designers of irrational boilers secure results on trial which are just what they had predetermined they should be.

The high-speed rational boiler consists essentially of three horizontal drums connected by tubes, so arranged that they resemble an L; the horizontal tubes [illegible] along the crown of a furnace; the flame passes [illegible] this through openings in a fireproof wall to a combustion chamber, from which again the hot gas rises through a forest of vertical tubes, uniting the upper and lower drums, and thence flows downward through another forest of vertical tubes uniting two more drums, which is called the economizer. Here they are got hold of by a big exhaust fan, and so sent to the chimney.

There are in all five drums. The furnace arrangements are such that we should not be surprised to hear that the bricks "dripped" in the combustion chamber as they did with the Cornish boiler in the original experiments. Honestly, we have no exception whatever to take to the design of the new boiler as the embodiment of Dr. Nicolson's theories. But there our approval we fear, must end. The generating tubes are only 5-in. diameter, with a bore of ⅜-in. The economizer or feed heater has tubes only ½-in. diameter and ¼-in. bore. It must, of course, be understood that circulation is maintained by a rotary pump. We fail to see how dry steam can be made. We should, indeed, anticipate heavy priming. The use of tubes of such small diameter and some 10 ft. or 12 ft. long will not, we think, commend itself to engineers. We may safely leave the settlement of the endurance of this generator to time.

It may be asked after all in what way is Dr. Nicolson's generator better than its predecessors? Such, for example, as its congeners of the Stirling type. The reply is that for equal powers it is much smaller; also that it is much cheaper to work. Dr. Nicolson compares a "rational high-speed" generator with an ordinary water-tube boiler, each making 10,000 lbs. of steam per hour. The first will cost £855 per annum, the second only £695—a saving at the rate of £320 a year per 1,000 indicated HP. installed. As to space, he estimates that in the "Lusitania" no less than 37% would be saved by the substitution of his for Scotch boilers. We have done our best to place Dr. Nicolson's boiler fairly before our readers. If he is successful in producing a steam generator which will satisfy the demands of purchasers in the way he hopes, then he will have done really a new thing in boiler engineering. But he will no doubt be the last man to be surprised if his claims are regarded with incredulity. Faith in long boiler tubes of small diameter and intensely heated has been worn very thin.

Concerning Examinations and Their Limitations.

The New York "Times," whose support of the McGrath bill for licensing engineers we commented on last week, comes back at us anew in the following fashion:

"Engineers," says the Engineering News, which ought to know, and does, "are well aware that there are plenty of incompetent and unreliable men doing engineering work."

That statement admits the existence of a condition endangering the public safety in no small degree, and that admission would seem to necessitate the further admission that something ought to be done to protect the public from the frequently serious consequences of careless or ignorant engineering.

Neither admission, of course, involves an enforced approval of the McGrath bill to establish an examining and licensing system of much the same sort as that which now enables the man who wants the services of a doctor or a lawyer easily to find one who by fair presumption is of respectable standing in his profession and knows at least the rudiments of his art.

What one might expect of the Engineering News, however, is recognition of the fact that the nominal object of the McGrath bill is a good one, and a convincing argument showing that, though the good object cannot be obtained in the particular way proposed by that measure, the same end can be reached by some other device.

Instead the News contents itself with asserting that the l[illegible] system is not considered by engineers likely to keep [illegible] competent men from positions of responsibility; that [illegible]ld give the public a false sense of security; and th[illegible] would impose upon the engineer the heavy burden [illegible]aking out licenses in many states.

Without [illegible]oing so far as to declare these objections invalid, we do venture to say that not all of them, viewed in the [illegible] of experiences in other professions, are obviously [illegible] truth and weight, and to add that, granting them a[illegible] they seem rather to demand the amendment of the l[illegible] than its abandonment.

We can answer the chief point which our contemporary attempts to make very briefly by quoting from the report of the Committee on Public Relations of the American Society of Mechanical Engineers. That Committee recently considered the proposed legislation requiring engineers to be examined and licensed and declared that by far the best way to secure public safety in connection with engineering work was *to inspect the work itself*.

This is already done, to a very large extent. Public supervision of buildings, of water supplies, of sewerage, of steam boilers, and of numerous other works with which engineers have to do, is already in force. Engineering News believes that public safety is thereby secured to a far greater degree than it could be by any system of examination and licensing of engineers.

If our contemporary desires a further proof as to the impotence of the examination and license system, we may remark that what we said of engineers is equally true of physicians and lawyers. There are plenty of incompetent and unreliable men practising the legal profession and practising the medical profession, and this notwithstanding the fact that the examination and licensing system is in full force in both those professions, and has been for many years.

We are not arguing that the system should be abolished in these professions. Probably it does some good there; and it is the only way in which the public can be at all protected. You can't inspect the plans or the finished work of the doctor or the lawyer. The mistakes of the former are buried and the latter can always lay the blame on the judge and the jury. But the engineer's work has to be done in the sight of everyone, where there is plenty of opportunity to criticise and check and amend.

We desire at the present time, however, to consider the broader question which has been raised by the recent discussion of engineer's license legislation, and that is the question to what extent the examination system, as a whole, is really advantageous and beneficial to the public. Since the first introduction of "civil service reform," a quarter century ago, great strides have been made in securing the incorporation of the examination system as an integral part of our system of government. It is worth while to seriously consider the so-called "merit" system on its merits and see what are its limitations and its defects.

No candid, intelligent man doubts to-day that it was a great step in advance to require appointments to public office to be conditioned on some test of ability instead of on the previous political service or pull of the applicant.

But this ought not to blind us to the faults of the examination system and its inadequacy to give more than a partial indication of the real value and efficiency of a man. It is a fact that engineers, holding responsible governmental positions, who desire to promote "efficiency engineering," find themselves continually hampered by existing civil service laws and regulations. In conversation with a prominent engineer, recently, in response to a tentative suggestion that the examination system was sometimes not an unmixed blessing, he declared with energy that he believed it the greatest curse the engineer had to deal with to-day.

Another engineer of the highest standing, speaking from intimate personal experience as the head of a great city department, declared that the greatest obstacle to the efficient reorganization there was that the department was controlled by the civil service law. The men in it, almost without exception, had secured their positions and promotions through civil service examinations and were protected by the law from being displaced except by a formal trial on charges preferred.

We are well aware that this latter feature of the civil service law was necessary in order to prevent politicians from nullifying it; but its effect to-day on the efficiency and the esprit de corps of many a public office is simply deadening.

The ideal of the civil service examination is fine. It is a test adopted to determine the fitness of an applicant to perform the work of a given position, and it is assumed that this adaptation is so perfect that if one applicant passes with a mark of 87½, while a rival applicant has 88, the latter is therefore the man best qualified to perform the duties of the office and the one whom the law should prescribe for appointment.

This is the ideal; but in actual practice we find men cramming for civil service examinations just as they do for college tests. Special schools are conducted to coach candidates. The marking of papers is always and necessarily a process very far from mathematical accuracy.

We need not say to our readers that Engineering News stands and has always stood for ability as the criterion for public service. We stand and have always stood for a proper tenure of office for competent officials. But we cannot blind ourselves to the fact that methods established for testing ability often fall far short of accomplishing their object, and that the safeguards established to protect competent men from the political executioner are often utilized as a shield for the lame and the lazy.

We have no remedy or panacea to propose for this condition, and we doubt whether there is any remedy, short of such an advance in public sentiment as will prevent the bestowal of positions in public service as a matter of political favor and thereby make possible the repeal of the cast-iron legislation which at present controls appointments and removals. A great advance in public opinion has undoubtedly taken place in the last quarter century, and the time will come, we hope, when our civil service laws can be revised and greater liberty allowed in appointments.

Meanwhile, it is important that the public shall learn to gage the examination system at its real value, that it shall understand its limitations and its weaknesses.

We have already commented in these columns on the absurdity of selecting candidates for important executive positions by civil service examinations. If the public fully understood how little examinations can accomplish in testing the real ability and reliability of an engineer for high-class work, the proposition to make all engineers pass an examination as a prerequisite to practise would never receive serious consideration.

LETTERS TO THE EDITOR.

The Relative Economy of the Tehuantepec Route Across the Isthmus and of the Panama Canal.

Sir: In your editorial comment on the relative cost of handling freight via the Tehuantepec route as compared with the Panama Canal, in your issue of Jan. 19, p. 77, you do not appear to have taken account of the time required to discharge and take on cargo. Would not the four days' sailing time saved by reason of the shorter distance be offset by the time required to unload and reload the vessel?

Ira W. Sylvester.

Alexandria, La., March 23, 1911.

[The loss of time of the vessel while lying idle should of course be taken into account. This expense, however, would obviously be very much less per day than the cost per day of running the vessel while on her voyage.—Ed.]

Reinforced-Concrete Column Footings.

Sir: Referring to the problem submitted by Mr. R. G. Doerfling in your issue of March 16, on column footings, I would cite some literature on this subject that is not at all evasive. Reference is made to my paper, "The Design of Reinforced-Concrete Columns and Footings," published in Engineering News, July 12, 1906; also to the discussion which followed the same. All of this is included in my book "Concrete." On p. 224 of "Concrete" there is a cut of a footing reinforced in an identical manner to that shown in the sketch in Mr. Doerfling's letter, even to the number of rods. This cut is given to demonstrate the absurdity of reinforcing a square slab in this common or "standard" method.

In my article I showed all rods passing under the column or plinth of concrete resting on top of the square slab. Two sets of rods were parallel with the sides and two sets lay in diagonal direction. This is the rational way of placing the rods.

A critic objected to this method of placing the rods and said that the bending moment at the center of the footing is $\frac{1}{8} P (l - a)$. This is with all rods equal in section and laid parallel to the sides, spaced equidistant both ways.

I showed that this formula, which is the same as the first one given by Mr. Doerfling, is incorrect. It is based on a blind kind of reasoning or analogy. The analogy is with steel grillage beams, when no analogy whatever exists. In grillage beams a set of beams, the lowest, receives the entire soil pressure; these transmit this entire load to the upper set of beams, and these react against the column. In the reinforced footing an analogous action could not possibly take place. One set of rods could not deliver their load to the other, because they are both identically conditioned. Neither set can deliver their load directly to the column, because only six of the eighteen rods lie under the column. Of course in speaking of the load of a rod, the rod here includes the constructive beam of which it is a part.

On the face of it, it is hard to imagine what possible use a rod could be lying out close to the edge of a square slab loaded at its center. But this is just another typical example of the quality of reasoning and analysis that is brought to bear on problems in reinforced concrete design.

Edward Godfrey.

Monongahela Bank Bldg., Pittsburg, Pa., March 21, 1911.

Wheel Loads of Electric Street and Interurban Railways.

Sir: The absence of any standard electric car loading led the writer to make an extensive study of the dimensions of interurban and city electric cars. The following table is the result of the investigation.

Frank E. Smith

1118 McGee St., Kansas City, Mo.

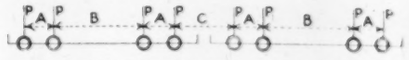

TABLE OF LOADINGS FOR ELECTRIC CARS.
(By Frank E. Smith, 1911.)

Class.	Weight of one car, tons.	P, lbs.	A, ft. ins.	B, ft. ins.	C, ft. ins.
INTERURBAN CARS.					
I—30	60	30,000	6 6	30 0	18 0
I—27½	55	27,500	6 6	27 6	17 0
I—25	50	25,000	6 6	25 0	16 0
I—22½	45	22,500	6 6	22 6	15 0
I—20	40	20,000	6 6	20 0	14 0
I—17½	35	17,500	6 0	17 6	13 0
CITY CARS.					
S—22½	45	22,500	4 6	18 0	20 0
S—20	40	20,000	4 6	17 0	18 0
S—17½	35	17,500	4 6	16 0	16 0
S—15	30	15,000	4 6	15 0	14 0

NOTES: Live load equals from 9 to 12 tons. Weight of one car as given is sum of dead load and live load. Most common classes I—22½, S—20 and S—17½.

An Engineers' and Surveyors' License Bill in Alabama.

Sir: Enclosed herewith we hand you a copy of House Bill 414, which is now before the legislature of this State, in which it is proposed to establish a board of examiners for the purpose of licensing all engineers in the State. Having read your criticism of the bill which was proposed in your State, we enclose this, thinking it possible that you might wish to compare them. We are opposed to this bill, inasmuch as we fail to see where any good can result, either to the State or to the profession.

Motley & Dryer.

Birmingham, Ala., March 25, 1911.

[The bill proposes licensing separately (1) civil engineers, (2) mining engineers, and (3) surveyors. After June 1, 1912, maps and plans for public record must be certified by a licensed surveyor, and drawings, specifications or estimates for public record must be signed by a licensed engineer; no construction work may be supervised or directed and no public employment as engineer may be held, by other than a licensed engineer; no monuments may be set or disturbed, and no public office as surveyor may be held, by other than a licensed surveyor. "Instrument men, rodmen and other subordinates on engineering or surveying work" need not be licensed if directly under the supervision of a licensed

engineer or surveyor and responsible only to him.

Licenses are to be issued by a board of seven examiners, comprising the Deans of Engineering of the Alabama Polytechnic Institute and of the University of Alabama and five other licensed engineers elected one each year by letter vote of all licensed engineers. For the first, the five members-at-large are to be elected by the Alabama members of the Engineering Association of the South. Examinations are to be held twice a year.

Licenses are to be issued (1) on examination; (2) to those practicing at the time of passage of the bill; (3) to graduates of the appropriate courses of the two colleges already named or of others having equivalent standing, after two years' experience as surveyor or four years' experience as civil or mining engineer; (4) to non-graduates, without examination upon four years' experience as surveyor or eight years' experience as civil or mining engineer, half this period to be in responsible charge of work; (5) to any engineer holding a license in any other state; (6) to a member of the American Society of Civil Engineers; (7) to a member of the American Society of Mining Engineers (*sic*); (8) to any engineer "holding office not lower than Junior Engineer under the United States Civil Service or to any military engineer for the Federal Government." The fees are $5 for certificate as surveyor, $10 for certificate as civil or mining engineer, $15 for combined certificate as civil and mining engineer. In cases 6-8 above the fee is $5. Temporary licenses up to the next following examination are to be granted on endorsement of two members of the Board.

The members of the Board other than the secretary are to receive no compensation except for traveling expenses, the secretary receiving $100 per year additional. After the first Board, subsequently elected members to be eligible must be licensed engineers, must be over 30, and must have had at least eight years' experience. Three constitutes a quorum of the Board (of seven), and three affirmative votes are enough to certify successful passing of the examination.

Violation of the law is to be classed as a misdemeanor and punished by a fine of $20 to $500.

To the above essentials of the bill we may add that the act apparently defines a civil engineer as one capable of designing and supervising

any public bridge, railroad, harbor, canal, dock, waterway, highway, sewer, sewerage disposal plant, filter, water-works, ditch, mine, tunnel or work of similar nature,

and the civil engineer's certificate is to state that he is authorized to design or supervise any of the above works and in addition has all the privileges of a licensed surveyor. The mining engineer's certificate is to show simply that besides having the privileges of a licensed surveyor he may design or superintend "any and all branches of mining engineering work."—Ed.]

On the Methods of Mine Surveying.

Sir: Referring to the article on "Coal Mine Surveying and Engineering" on page 168 in your issue of Feb. 9, 1911, I was much surprised to find this otherwise well balanced and thoroughly practical monograph recommending the old and obsolete system of turning "rights and lefts" on transit work in mines.

The generally excepted method of running mine surveys is by the continuous vernier. In this system the transitman sets up at the last station on the entry, and with the telescope reversed and the vernier on the azimuth of the last two stations, he back-sights on the next to last station and plunges the telescope over on the fore sight, his instrument being then set on a true azimuth. After carefully reading the vernier he moves to the next station, sets up, checks his vernier to insure against its having been moved, takes the back sight as before, checks his vernier again, and then plunges on the fore sight. This system has the following advantages:

(1) The instrument does not have to be set at zero at each station.

(2) The transitman has the azimuth with him continually and can put in sights at any time and on any course without having to figure up his angles.

(3) It eliminates the possibility of error due to mistaking a right for a left.

(4) Each reading of the vernier is checked twice.

(5) If a mistake is made in one reading it does not effect the accuracy of the following readings.

(6) It eliminates accumulative errors. On the other hand, in a run of say 20 set ups (a good day's work when side-notes are taken and rooms run) by the system of "rights and lefts" and allowing an error of one-quarter of a minute at each set up, either in setting on zero or in reading the final angle, and assuming that all the errors fall in the same direction, the total error at the end of the run would be 0° 5'. While the assumption that all the quarter minute errors fall in one direction is perhaps a little strong, we cannot, on the other hand, trust to Providence that they will balance each other.

A. T. Shurick,
Engr. of Coal Properties,
Amalgamated Copper Co.

Washoe, Carbon Co., Mont., Feb. 15, 1911.

Formulas for Suspension Bridge Calculations.

Sir: In the new edition of Part II., "Modern Framed Structures," a statement should have been inserted in the chapter on Suspension Bridges, giving due credit to the Department of Bridges of New York City for the application of Melan's "exact theory" to the calculation and design of the Manhattan Bridge. As presented by the writer in the report of Mr. Ralph Modjeski to the City of New York, and published in Engineering News, Vol. 62, page 401, Mr. L. Moisseiff, of the New York Bridge Department, is fully credited with a development of this method of calculation, although the demonstration given by the writer and the working formulas for *H* are considerably different from those used by Mr. Moisseiff.

In all copies of this work hereafter issued the following statement will appear on page 276, and a similar statement will be inserted in the preface:

Based on the work of Melan, "Eiserne Bogenbrücken und Hängebrücken," Leipsic 1888 and 1906. This method was fully developed by Mr. L. S. Moisseiff of the Department of Bridges of the City of New York, and used in the calculations of the Manhattan Bridge, and again by the author, with various modifications, in the recalculations of this structure for the report of Mr. Ralph Modjeski to the City of New York. See also Max am Ende in Proceedings Institution of Civil Engineers 1898."

F. E. Turneaure.

University of Wisconsin, Madison, Wis., March 30, 1911.

Can Some Prizes be Withheld in a Prize Competition Award?

Sir: It may be interesting to readers of Engineering News, particularly to those who have participated in prize competitions for designs of monumental structures, to learn that in a recent case when prizes had been advertised for the three best designs of a viaduct, and only two awarded, the body which offered them was compelled to award the third.

The case referred to is the Grand Avenue Viaduct at Milwaukee, Wis., a reinforced-concrete structure about 2,000 ft. long, estimated to cost $400,000. Three prizes ($1,500, $1,000 and $1,000) were offered for the three best designs. The report of the Commission of Award to the Board of Supervisors of Milwaukee County showed considerable difference of opinion among its members as to the relative merits of the three best designs, which resulted in the Board awarding but two prizes, the third-best design being given honorable mention.

Exception to the awards by the Board of Supervisors was taken by the engineer whose design should have been awarded the third prize. An appeal was then taken to the Board, which was ignored. Mr. C. Frank Class, Assoc. M. Am. Soc. C. E., of Camden, N. J., who submitted this design, then entered suit against the County of Milwaukee for the amount of prize money, $1,000. Nearly four years elapsed before the plaintiff's attorneys were able to get the case to trial. As soon as the call for a jury was started, the District Attorney indicated a desire to settle, and agreed on a settlement of $900, which was approved by the Board of Supervisors.

The result of the case shows that, where prizes are advertised to be given, those who offer them are bound to either award or reject them all. It is not fair nor lawful to those competing to eliminate one or more of the prizes offered.

"Viaduct."

Jan. 4, 1911.

[The writer of the letter is in error if he believes that the action of the District Attorney of Milwaukee County establishes any law or legal practice.

We are not aware that enough cases of the kind have come up in the United States to create well-established law; and we know that even in the relatively fixed though closely related subject of public contracts and specifications the decisions of courts are not always in agreement. Sound practice in prize competitions requires, we believe, that among other principles the following two be strictly observed: (1) Any performance specified and any inducement held out in the call for designs or bids must be maintained to the letter; and (2) All competitors should be treated on an equal basis. It follows from these principles that in awarding prizes only those designs and bids can be considered which come up to all the expressed requirements and that all competitors should have equal rights in this point; and further that if it is intended to reserve the right to withhold *any* or *all* prizes the call for designs should contain a definite announcement of this fact. In the Grand Avenue Viaduct prize competition only the right to withhold *all* prizes was reserved, apparently.

This prize competition was reviewed quite fully in our issue of Feb. 14, 1907, with illustrations of the two designs awarded prizes and a reproduction of the report rendered by the board of judges. However, a minority report was not mentioned in that article; such a report was rendered by one of the three judges, referred to below.

The call for designs contained the statement:

All designs must comply strictly with the rules laid down in the program for this competition.

As we understand the matter, these "rules" include the cost limitation of $400,000 and the space limitation set by the location of the land acquired by the County.

The "Information to Competitors" also contained the statement as to prizes (italics ours):

The designer whose plans and specifications are considered the best *will be given* a prize of $1,500, one of $1,000 *will be given* to the second best and a prize of $1,000 *will be given* the third best design.

In the "Official Notice" we find also:

The board of supervisors shall select from among the plans and specifications the first, second *and third best* ones. * * * To assist the board of supervisors a board of judges has been appointed. * * * Three prizes will *be awarded* to the successful competitors; but the county reserves the right to withhold the award of prizes, should *none* of the designs and specifications submitted come up to the standard of excellence called for in the program.

Evidently this says that all three prizes might be withheld, but that otherwise all three were to be awarded, so long as three designs meeting the specified requirements were submitted.

Referring back to our issue of Feb. 14, 1907, we find the report of the majority of the judges (Mr. Ralph Modjeski and Prof. F. E. Turneaure) to say in effect, that the design considered best (Concrete Steel Engineering Co.) was probably somewhat too high in cost, but that by modifications not contemplated by the designers the cost limit could be met:

An examination of the detailed estimate leads us to believe that a considerable reduction in cost may be effected by using a somewhat less rich concrete in certain parts so that the total can be reduced to the limit of $400,000.

Comment to the same effect is passed on the second-best design (C. A. P. Turner), where by omitting ornamental work "the total cost will be brought within the specified sum."

The third-best design (C. F. Class) was or could be brought within the specified sum, but "the location of the bridge would have to be changed" to suit the land available. It is not apparent that this departure from the specified conditions was considered more serious than the overrun of cost in the other two cases. In fact the wording of the conclusion indicates that the refusal of a prize was based squarely on opinion as to merit of design:

We recommend that design No. 3 be given honorable mention, as it does not, in our judgment, have sufficient merit to warrant its receiving a prize.

The wording of the Official Notice, etc., did not authorize such action, however, as brought out above.

Mr. G. Steinhagen, the third member of the board of judges, in minority report recommended that the Concrete-Steel Engineering Co. design be given first prize, but made no recommendation as to other prizes. In a letter to us he states as his reason for making a minority report that

neither C. A. P. Turner's nor Class's plans were strictly in compliance with the program.

The legal question of interest would then be: Assuming on the facts that at least one plan which did not strictly comply with the specified conditions had been awarded a prize, can the refusal of a prize to another plan be based on non-compliance with the program conditions? Further, since the majority of the board of judges

clear[illegible]ed the Class design third, and based its r[illegible] of an award of third prize on lack of merit, [illegible]herefore waived the plea of non-compliance [illegible]h program conditions, was its action and th[illegible]sequent action of the Board of Supervisors i[illegible]hholding third prize a violation of the promises [illegible]d out in the call for designs?

Commo[illegible]sense must furnish our answers to these que[illegible]ons, in view of the settlement of the case out o[illegible]court. The official recommendation of the District Attorney to the Board of Supervisors represented that a settlement was the cheapest course for [illegible]he County.

While p[illegible]e competitions for designs are fortunately not common in engineering work in this country, it[illegible]s much to be hoped that proper procedure in such competitions may become so well settled as to avoid disputes over questions of the kind involved in the present instance.—Ed.]

Development of New York City's Water Terminals.

Sir: In your issue of March 9, 1911, you comment severely upon my attitude as Dock Commissioner in requesting temporary permission from the United States Government to extend the Chelsea pierhead line. Your criticism is summarized in the concluding editorial paragraph:

> The responsibility for the present state of affairs, we regret to say, rests largely on the New York City dock authorities, who with years of time made no preparations for what changes were in prospect. The coming and going of the political heads of the Department of Docks and Ferries is not sufficient excuse, in this instance. For, Mr. Calvin Tomkins has been Commissioner at the head of this department for more than a year, yet *he has done absolutely nothing* to provide for the "Olympic," until this eleventh hour emergency plea for the special privileges which the department and the shipping companies coveted. Under these circumstances, there is some hope in the establishment of a joint commission of the states of New Jersey and New York and the War Department, to consider broadly the development of the port.

In answer, let me briefly present my own side of the case, involving a consideration of commercial as well as engineering features.

Cheap terminal handling of commodities lies at the foundation of the prosperity of the port. Terminal matters are not popularly understood, as are city problems relating to subway transportation, police, sanitary government, etc., consequently they are neglected until necessity consequent upon neglect becomes apparent and then the difficulties are not always easy to solve.

The time has arrived to organize the port as a whole in contradistinction to the policy of providing separate docks for separate uses. Growth under pressure instead of as a consequence of design has been the characteristic of New York's development and it is not surprising that former administrations have not been able to provide what the city needs more than anything else; namely, a port development policy. It is not fair to criticise past governments too harshly, since there was no sustaining public opinion behind them.

I agree with you that conditions have now changed and that as Dock Commissioner I shall be justly open to criticism if the city's problem is still permitted to drag or if the department shall enter upon a mistaken plan of development. There is too much general interest in the subject now to excuse a commissioner from not falling back upon it for support to carry out any policy he may determine wise.

Your italicized statement that I have done absolutely nothing would be more correct if made to read that I have not done much as regards physical accomplishment but that I have, with the assistance of the department's engineers, at least thought out a tentative plan and policy which has been in part outlined.

In anticipation of the large release of credit available for the Dock Department, based upon exempting self-sustaining dock bonds from the debt limit, the policy of the Comptroller and the Board of Estimate and Apportionment has been to cut down the appropriations for the Department to a minimum. I have not objected to this so far, as it has given us an opportunity to prepare our plans and it seemed just in view of the large credit to be available in the near future ($60,000,000 to $70,000,000), that the needs of other departments should be considered first. The matter will soon be decided by the Appellate Division. Figures have already been submitted by the Department to the Comptroller. Our general policy has been outlined in a series of reports and we are prepared to execute it as soon as we shall be placed in funds.

Plans for terminals at South Brooklyn and also on the west side of Manhattan, involving both steamship and railroad location have been published for discussion and additional reports on terminal facilities in other boroughs are in process of preparation and will soon be issued.

I believe that no permanent narrowing of the river should be permitted in the Chelsea district. This is, at present, the narrowest part of the stream and considering the immense volume of traffic which will in the future pass through it, it is undesirable that any permanent obstruction should be permitted to diminish its width. But I see no reason for refusing a temporary extension which will in no wise interfere with the movement of commerce at present and which will permit the city to determine upon some comprehensive plan while the temporary permission continues. The government has acceded to the request of the city and the steamship companies in granting a two years' permit for the extension of the piers, and it is hoped that during this time the city, in conjunction with the two states and the Federal officials, may determine upon a permanent policy, the carrying out of which the government should seek to facilitate in every way possible.

Under date of Feb. 16, I addressed a letter to the Harbor Line Board as follows, which I think quite definitely states what I believe should be the relations between the city and the Federal government in connection with this matter:

> Dear Sirs: In appearing at the hearings on the application of the International Mercantile Marine for the extension of its piers, I stated what I believed to be the urgent commercial reasons for granting the extension asked for.
>
> If the judgment of your Board should be that an extension is permissible, but should be of a temporary character, I write to suggest that an indeterminate permit be granted, revocable on reasonable notice, say five years. This will permit the City of New York gradually to adjust its port policy to the requirements demanded by the Federal authorities. In the arguments which have so far been adduced, attention has not been directed to the fact that the City of New York cannot suddenly inaugurate a comprehensive development plan for the harbor. The failure to provide such a growing plan for the port is regrettable but the problems connected with the development of a port policy are so large and complicated that a reasonable time must be permitted for thinking them out and taking the initial steps of construction. Questions of finance and commerce are involved which add to the difficulties.
>
> Under a recent Constitutional amendment, self-sustaining dock bonds are exempted from the debt limit of the city, and the funds thus released may be made available for future dock improvements. It is my desire, as far as possible, to keep this dock improvement fund intact for a sequence of public improvements. This can be done by undertaking improvements which will promptly become self-sustaining, thus continually releasing the funds temporarily locked up.
>
> I have now in contemplation a gradual improvement of the west Manhattan waterfront, which, I think, can be made a self-sustaining enterprise, almost from its inception. I shall also propose the acquisition of the Bush Terminal piers at South Brooklyn, which, in conjunction with the riparian lands to the north and south of the Bush docks will constitute another self-sustaining improvement in the near future. Both of these improvements can be extended and still kept in the self-sustaining class.
>
> In order to keep our funds as nearly intact as possible, it will be necessary to maintain the Chelsea docks, at least for some years, as self-sustaining enterprises; they are hardly so now. To readjust the contracts and financial relations between the steamship companies occupying these docks and the city will interfere with and involve serious financial difficulties, both for the companies and the city and, in my judgment, it is desirable that these difficulties should be avoided, at least until such time as the city shall have determined upon a progressive development policy.
>
> I would suggest that no specific time limitation be imposed upon the city in any permit which may be granted, at least until its development plan and policy shall have been adopted. I think within two years this may be accomplished. The extensions to the piers can then readily be ordered out by the Federal authorities on reasonable notice and a definite time fixed. The construction is such as to permit of this being done quickly and without great expense, whenever in the judgment of the Federal authorities it may be deemed desirable to act. The dilatoriness of the city in providing a development plan should not be used against it as a reason for immediate enforcement of a time limit, since this will greatly complicate and add to the difficulties of a trying situation.
>
> I may say, that it is my intention as Commissioner of Docks, in cooperation with the Federal and State authorities to do everything possible to provide such a growing plan for the commerce of the city as quickly as possible.
>
> A very great difficulty the Dock Department has to contend with is the fact that the waterfront problems of the city are not generally understood. The State of New York must make provision for terminals for the improved Erie Canal and the Federal authorities also need special facilities in this port which, I believe, should be acquired at various points. In addition to these facts, the Federal authority, through its control over the harbor lines, can greatly influence the local policy of port development.
>
> I know it will be to the advantage of the city and the Dock Department if the State and National governments shall become actively interested in influencing the development of the port policy of New York, and I shall hope to secure the active cooperation of your Board with a view of affording continuity to any policy which the city may finally enter upon.
>
> Yours respectfully,
> Calvin Tomkins, Commissioner of Docks.

The city should seek to put each part of the port to its best use, either commercial or industrial as local circumstances may determine. Manhattan, at the center of the port, has naturally attracted commerce and industry in the early years and one of the problems of reorganization consists in providing modern terminal facilities in outlying districts about the port which shall induce factories and the industrial population incidental to them to migrate from the central borough to the outskirts thus relieving the unsocial and uneconomic congestion which is so obvious in Manhattan.

Passenger vessels of the first class seek terminals at Manhattan for the same reason that the Pennsylvania Railroad has established its terminal station here. Convenience of handling baggage and the fact that the package freight which they bring is almost all destined for Manhattan makes dockage here desirable. These ships are to be considered as great floating hotels, connecting the hotel and railway system of Europe with that of the United States. The passenger business has developed to phenomenal proportions within the last fifteen years. The passengers seek to land at Manhattan for hotel accommodations, amusements, shops, wholesale business and for railroad connections which are more accessible here than in any other borough. If these large ships are not provided with terminal facilities here, the conveniences of the port will be interfered with.

There is no difficulty about taking these large ships elsewhere. The Department now has a dock available at Staten Island and another at South Brooklyn to which they could immediately proceed after a small amount of dredging shall have been arranged for. They could also go to New Jersey opposite Manhattan; but all of these places are second or third choices as compared with Manhattan, and to decide that Manhattan shall not be used is in fact to say that that part of the harbor shall not be put to its best use.

If, as you say, there will not be many longer ships, the problem will be correspondingly easy. New York's facilities alone do not determine the length of the ships to be built. This is rather dependent upon facilities afforded by other ports, although New York is doubtless the principal determining factor. We are now preparing plans looking to the provision of two new piers in the Gansevoort section between those of the Southern Pacific and the Cunard lines. By excavating into the upland, the city can secure two half piers of over 1,000 ft. in length, with storage facilities at the rear. Plans for these will soon be out and I should like to have your criticism regarding them.

The Department contemplates that the lower west side of Manhattan, below the Chelsea district shall ultimately be devoted to steamship uses and that the railroad business which is now obstructing the waterfront with its car float moorings shall be moved to the north. The car floats can be moved up and down the river parallel with the Jersey shore, crossing the stream above 23d St., where landings can be made and the cars transferred over bridges and ramps to an elevated railroad and conducted into terminals located at various places on the east side of West St. down to Washington Market.

Such a concentration of car floats above 23d St. with terminals strung along the east side of the marginal way will ultimately make it feasible to relinquish the waterfront below 23d St. to steamers and marine commerce generally. This I believe to be the solution of the waterfront terminal problem in Manhattan. The pierhead line can be straightened in front of the incurving shore of the city in this reach and piers 1,050 ft. in length can be secured without extending the pierhead line beyond the Chelsea and Battery limits. The city will doubtless petition the general government, however, for a material extension of the pierhead line in this district adjacent to the wide mouth of the Hudson River.

As Dock Commissioner, I have ventured to take the responsibility of initiative in suggesting a port policy for the city of New York at South Brooklyn and along the west side of Manhattan. As a result of outside criticism and suggestion, this policy has been modified in some minor particulars, but the general features, namely, of municipalization of the waterfront and connecting it to the factories and warehouses adjacent to it with a parallel marginal railway in conformity with the general practice of the great ports of the world have not been changed. I should like to have your criticism of this general plan as set forth in the general reports which I have recently issued and copies of which I submit to you herewith.

I realize that in endeavoring to evolve a comprehensive plan for the port, many initial misconceptions must be overcome, and I am glad to receive criticism and entirely willing to make changes necessitated as a consequence of criticism.

I am also impressed with the fact that development plans cannot be forced but that the city must create conditions favorable to proper development, and that as a normal consequence of the imposition of such conditions the desired development will proceed along lines of design rather than of accident.

The Federal government is right in its endeavor to prevent encroachments upon the harbor which shall prejudice its best uses in the more distant future, but it is also essential that contemporary commercial necessities should also be given consideration so that the conditions for maintaining the future integrity of the harbor shall not prejudice its present use.

The city has too long neglected to provide itself with a plan of growth. This may or may not be excusable, but it is a fact which must be given consideration. It will not be possible to suddenly change the existing status. This must be gradually molded, and it is necessary that the Federal authorities shall permit the city sufficient

time to think out and carry out a forward policy. I have endeavored to provide such a policy for the city as indicated in the reports which I submit, and I should be pleased to have your *constructive suggestions* and criticisms regarding these reports.

Nature has provided exceptional opportunities at New York. On the other hand, the city has been indifferent as to the proper utilization of these opportunities. The railroads in connivance with other seaboard cities and the Federal government have discriminated in their freight rates against New York in favor of Boston, Philadelphia and Baltimore. New York must seek to so utilize its natural advantages as to obtain the maximum use from them, and it must also insist upon being permitted to enjoy the full advantage of the level route leading from the seaboard to the Mississippi valley, which route can be made to control railroad rates in the United States more effectively than can the Interstate Commerce Commission, not only over the Allegheny Mountains to other cities, but north to Montreal and south to New Orleans.

Yours respectfully,

Calvin Tomkins, Commissioner of Docks.

[We are glad that Commissioner Tomkins goes on record as opposed to any permanent encroachment on the Hudson River at its narrowest stretch, where the permit for a temporary pier extension has just been made by the Secretary of War, as a result of the pressure from a long array of public officials, from the President of the United States down. We hope his policy will be adhered to by the department of which he is the head. If piers longer than those in the Chelsea section are necessary, they can be furnished, as Mr. Tomkins himself states, above, in the Gansevoort section, or in the section above 23d St., without encroaching on the navigable channel.

The main subject discussed in Mr. Tomkin's letter, the plans for freight terminals, to be owned by the city and leased to transportation companies, is taken up elsewhere in this issue in an article in which both the Dock Department plans referred to by Mr. Tomkins and the plans prepared by engineers of the Board of Estimate are fully described.—Ed.]

THE COMMISSION PLAN OF CITY GOVERNMENT for Nebraska cities and towns of over 5,000 is provided for by a bill before the legislature of that state. The bill follows the usual line of commission plan legislation. Cities of over 100,000 would have seven councilmen, and all others five councilmen. The councils themselves would decide, after election, which of their members should be mayor and heads of the respective city departments. It is reported that there is opposition to the bill because, if enacted, it might lead to an overturn of the present city government of Omaha.

MUNICIPAL OWNERSHIP OF LANDS within the city limits has proven profitable in the city of Regina, Saskatchewan, Canada. The lands referred to were granted to the city in its original charter. The revenue derived from them is now sufficient to pay a large part of the cost of a complete sewerage system for the city, which is now being constructed, involving an outlay of about $500,000.

IMPORTANT CHARTER MODIFICATIONS for nine Massachusetts cities are before the Legislature of that state. All of this legislation draws more or less upon the principles involved in the commission plan of city government, but there is much variation in detail. In some cities several different charters are under consideration, running to three in one case. Most of the proposed charters provide for either five commissioners or a mayor and four aldermen or councilmen. In one instance as many as 15 aldermen and in another as many as 21 are proposed. Broadly speaking, all nominations under the various proposed charters would be by petition, generally with only 25 or 50 signatures. Generally, also, provision is made for the election of some or all of the city officials at large instead of by wards. Nearly all the proposed charters call for a small Board of Education, with the Mayor as one of the members. Practically all of the bills make provision for the initiative, the referendum and the recall. As a rule, heads of departments would be elected by the commissioners, councilmen or aldermen. A tabulation and textual analysis of these charter reform bills appeared in the Boston "Transcript" for March 15, 1911. The following nine cities are included: Brockton, Cambridge, Chelsea (two plans), Lawrence (three plans), Lowell, Malden, Marlboro (two plans), Newburyport, Pittsfield (three plans). In addition to the bills reforming charters of specific cities, one bill has been drawn in the form of a general permissive charter. According to a recent issue of the Springfield "Republican," Massachusetts now has four commission form of government cities, namely, Taunton, Haverhill, Gloucester and Lynn.

The Fire Underwriter's Report on the Asch Building Fire.

The New York Board of Fire Underwriters', through its Bureau of Surveys (F. J. T. Stewart, Superintendent), has just issued a report on the Triangle Waist fire described in our issue of March 30, where 145 employees were killed. We reprint the main part of the report below, with three of the illustrations accompanying the report.

The fire occurred on March 25, in a ten-story building at the corner of Washington Place and Greene Street. The three upper floors, occupied by the shirt-waist factory of Harris & Blanck, burned out. The Underwriters' report states the occupancy of the building in detail. The 2d, 3d, 4th, 5th and 7th floors were occupied partly for clothing manufacturing, only cutting being done, while the Triangle Shirt-waist factory in the 8th to 10th floors comprised mainly sewing-machine work; the first floor, basement and sub-basement were occupied for storage, the first floor and parts of the upper floors being also used as showrooms and salesrooms. The heating plant of the building was in the sub-basement.

FIG. 1. VIEW OF ASCH BUILDING DURING FIRE IN THE TRIANGLE WAIST FACTORY.

(The underwriters call attention to the ineffectiveness of the powerful hose stream directed from the street toward the window on the tenth floor. The portion of a stream at the extreme left is from a watertower; this water enters the tenth floor at a somewhat more effective angle but still is ineffective a few feet back from the window. The two small streams at the right are directed from a building 50 ft. away, across Greene St.)

CONSTRUCTION.—The Asch Building was designed to be used as a loft building. It was built in 1900-1901 and at the time of the fire was in excellent repair. It is ten stories high with an iron and glass 1-story extension in the rear and has a basement and sub-basement. It is of the steel and cast-iron skeleton construction. The building has an area on the first floor of about 10,000 sq. ft., while the upper floors are about 9,000 sq. ft. The walls are brick and carried on the steelwork at the floor levels. The walls range in thickness from 16 ins. at the first story to 12 ins. at the tenth.

The street fronts are brick, stone trimmed; the Washington Place front is stone for the first two stories. The walls and ceilings were plastered directly without use of furring. The north and west walls are parapeted about 4 ft., while the walls facing streets are without parapets. On three floors—the fifth, seventh and tenth—there were partitions of wood and glass forming offices and show rooms. On the ninth floor there were two wooden partitions, one forming the cloak room, the other being at the north side enclosing the entrance to the freight elevators and stair shaft. The cornice is of metal. There were two large skylights on the roof of wire [illegible] hollow metal frames. The floors are double [illegible] 1 in.) on wooden sleepers with a cinder concrete [illegible] flat floor arches of 10-in. terra cotta blocks, [illegible] struction, carried between steel I-beams (12-in., [illegible] about 5 ft. on centers. These I-beams are [illegible] steel I-girders (24-in., 80-lb.) reinforced by two [illegible] 10 × ⅜-in., 17 ft. 6 ins. long, riveted to the girder [illegible] each flange. These girders are 17 ft. 6 ins. on [illegible] and have a span of 26 ft. 3 ins. The columns [illegible] first eight floors are cast-iron, ranging from 1[illegible] diameter and 2¾ ins. thick to 7 ins. in diameter [illegible] ¾-in. thick on the eighth. In the ninth story [illegible] umns consist of four 4 × 4 × ½-in. steel angles [illegible] those supporting the roof are composed of only [illegible] angles. The roof is tar and gravel on terra cotta [illegible] similar in construction to the floor arches.

The beams are protected on the top flange [illegible] the floor arches, the lower flanges being protected by skewbacks having lips 1 in. [illegible] in thickness. The girders are protected on the upper flanges and lower portion of the webs by the floor arches, the lower portion of the webs and lower flanges are protected by cement plaster on wire lath. The columns are protected by sectional cellular three-cell 2-in. tile with ¾-in. webs, leaving no air space at the cast-iron columns, the steel columns being left hollow.

There are two elevator shafts, one for freight and one for passengers, each containing two cars; the freight shaft being at the northeast corner and the passenger elevator shaft at the southwest corner. The freight elevator shaft opens to the lofts by Kalamein paneled doors hung by butt hinges to metal straps built into shaft. The passenger elevator shaft opens to lofts by Kalamein doors with wire glass panels and is hung similar to the freight elevator doors. There are two stair shafts, each having one wall in common with an elevator shaft. Both the elevator and stair shafts are constructed of 4-in. hollow terra-cotta blocks and are covered by skylights of wire glass in metal frames. The stairs are of iron frame with slate treads with metal web-plates, the treads being 33 ins. long, with winders between each floor. The stairs in the northeast shaft were carried to the roof while those at the southwest corner ended at the tenth floor. Both stair shafts open to lofts by wood sash doors with wire glass panels, the panels being 33 × 36 ins. There are two inside stair flights from basement to first, enclosed in 3-in. terra-cotta blocks with wood sash doors and thin glass panels; one open stairs sub-basement to basement not trapped; these stairs are of the same construction as the main stairs. There are also a pipe and vent shaft and a wire shaft, each constructed of 4-in. hollow terra-cotta blocks, the vent shaft being carried through the roof and covered by a louvered skylight. The wire shaft is blocked at the roof. The vent shaft opens to the toilets by iron registers and Kalamein doors about 18 × 24 ins. The wire shaft has wood metal-lined panel boxes to the floors. There are also two sidewalk elevators from sub-basement to street, enclosed in shafts of corrugated iron and 4-in. hollow terra-cotta blocks with flat framed iron doors to basement and sub-basement. Fig. 1 shows an exterior view of the building during the fire.

The building was equipped with an automatic fire alarm system using "Western Electric" thermostats. There were 24 fire pails in sub-basement, 19 in basement, 10 on first, 14 on second, 12 on third, 16 on fourth, 8 on fifth, none on sixth, 18 on seventh, 26 on eighth, 37 on ninth, 18 on tenth. There is a 4-in. standpipe in each stair shaft with 50 ft. of 2½-in. linen hose at each floor, supplied by a 2,000-gal. tank elevated 5 ft. above roof, and an outside Siamese connection for Fire Department. There are perforated pipes in sub-basement and basement, supplied by outside Siamese connection for Fire Department.

On the rear of the building in the court is an iron fire escape, the steps being 17½ ins. wide. The platform between steps and wall is 18 ins. wide. The fire escape did not extend to the bottom of the court and the latter had no exit to the street.

CONDITIONS IN THE SHIRT-WAIST FACTORY.—On the eighth floor there were five unbroken rows of 4-[illegible] tables, each containing a double row of sewing machines and shirt waists in process of manufacture. These tables extended from the Washington Place front (south wall)

to within ... ft. of the north side of the building. This latter space was partially filled with stock, principally on tables. A ... space was also left running east and west along the north side. The space along the east wall contained the cutting tables. Approximately 275 operators were on this floor.

On the ninth floor there were eight unbroken rows of 4-ft. tables each containing double rows of sewing machines and shirt waists in process of manufacture. These tables extended from the Washington Place front (south wall) to within 10 ft. of the north side of the building. (See Fig. 2.) This latter space at the north side was partially filled with stock, and also contained an aisle extending east and west along the north side. Approximately 300 operators were on this floor. There were no aisles running east and west at the south side of the eighth and ninth floors, the sewing machine tables extending close up to the wall. The space between the tables was approximately 4 ft. wide and contained two rows of chairs back to back for the operators. This space also contained baskets and other receptacles for the goods in process of manufacture. The only convenient way for the operators next to the south wall to reach the stairs and elevators at the southwest corner, was to walk the entire length of the crowded space between the tables to the north side and then use the aisles which extended along the north and west sides of the building.

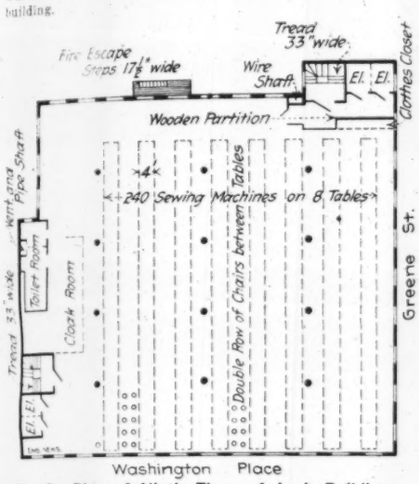

Fig. 2. Plan of Ninth Floor of Asch Building.

(This was one of the two work-rooms of Harris & Blanck. Most of the deaths came from the ninth floor. See also plan of the empty loft, in Eng. News, March 30, 1911.)

On the tenth floor very little work was done, it being used principally for the office, show and stock rooms, and shipping department. About 30 hands were employed on this floor pressing shirt-waists by gas-heated irons. Approximately 60 employees were on this floor.

LOCATION AND PROGRESS OF FIRE.—The fire started about 4.42 p. m., Saturday, March 25, 1911, on the eighth floor, in the vicinity of the northeast corner of the building, almost simultaneously with the signal to stop work for the day. It is generally believed to have originated from a match or cigarette igniting scrap material on the floor in the vicinity of the cutting tables. Futile efforts were made to extinguish the fire with pails of water. It spread rapidly, however, due to the large quantity of inflammable material, consisting chiefly of thin cotton, lace and other trimmings for fancy shirt-waists in process of manufacture. In a very short time the fire had spread over the entire floor and communicated, principally out and in the windows, to the floors above. In addition to the windows, the fire may have communicated from floor to floor by way of the stair and elevator shafts, as the doors were undoubtedly open in part at least. All information indicates that there was a large accumulation of inflammable stock in process of manufacture, and this undoubtedly accounts for the exceptionally quick spread of the fire over the eighth, ninth and tenth floors. The plant was working overtime when the fire occurred. Some firebrands started a fire on the first floor near the north windows.

LOSS OF LIFE.—According to the information obtainable the operators, crowded among the machines, chairs and goods on the eighth and ninth floors, were badly panic-stricken immediately after the start of the fire, and as a consequence made slow progress toward the exits. Considerable delay is said to have been experienced in opening the doors leading to the stairs at the southwest corner of the building as they opened inwardly and the women became jammed against them. Practically all the employees on the eighth floor eventually escaped by way of the stairways and elevators. The comparatively small number of employees on the tenth floor escaped chiefly by way of the stairway at the northeast corner to the roof, and thence to the roofs of adjoining building. Some also escaped by way of the elevators from the tenth floor to the street. Practically the entire loss of life was confined to those employed on the ninth floor. More than half of the number said to have been on this floor escaped. It seems apparent, however, that by the time this number had gotten out, the elevators had stopped running and the flames around the two inside stairways and outside fire-escape, both on this floor and those adjoining, would not permit any further egress in these directions. The result was that all who remained on the floor until this condition prevailed were overcome by the smoke and fire or jumped out the windows. It is said that a few, probably 20, from the upper floors descended by way of the outside fire-escape. These reentered one of the lower stories and passed down the stairways.

Approximately 25 bodies were found closely jammed in the cloak room next to the stair shaft at the west end of the building. About 50 were found near the northeast corner back of a partition and clothes locker located 30 ins. from the north end of the two tables nearest the east wall. Twenty were found near the machines where they worked, apparently having been overcome before they could extricate themselves from the crowded aisles. Most of them were near the east side. About 10 bodies are said to have been taken from the bottom of the court on the north. The balance of those killed—approximately 40—jumped from the windows to the street.

The total number of lives lost at this writing, 145.

DAMAGE TO BUILDING AND CONTENTS.—The upper three floors were completely burned over and practically all trim and finish destroyed. The damage to the structural part of the building on these floors was relatively small. The lower face of about one-fifth of the tile roof arches was broken off and the covering on one column supporting the roof was slightly broken. The parapet wall at the north court is out of plumb from 4 to 5 ins. at top owing to the sagging, under heat, of the unprotected channel-iron window-lintels which support it. The floor arches and column covering in the eighth and ninth stories was very little damaged. The lower flange of the girder supporting the curtain wall at the north side on the upper three floors was exposed. It was fireproofed by two inches of cement above the wooden window frames. The wire-glass panels in the pasenger elevator shafts on the upper floors had softened and rolled out of the framing in most cases, demonstrating again the unreliability of wire glass for inside stair and elevator protection. There was also some small damage to trim and finish by fire on the first floor. The water seemed to find its way through the fireproof floor arches with comparative freedom, and the finish on practically all floors was water-soaked.

The contents of the upper three floors were mostly destroyed. There was also some damage by fire to the contents on first floor. The contents on other floors were damaged by water.

DAMAGE TO EXPOSED PROPERTY.—The Asch Bldg. was exposed to the north across a court, by fireproof buildings having windows 15 and 30 ft. distant, protected by wire-glass windows or flat-framed iron shutters. The wire glass in some windows 15 ft. distant was softened but remained in place. The flat-framed iron shutters warped badly, permitting the fire to damage the wood window casings back of them. Otherwise, there was practically no damage to these buildings or their contents.

The 11-story fireproof building of the New York University had windows exposed 22 ft. west of the Asch Building across a court. These were protected by an inferior type of metal-clad shutters which poorly resisted the fire. The window frames on the top floor were destroyed and some others damaged. The books and furniture in one room on the top floor also sustained slight damage.

Summary.

This fire, on account of the great sacrifice of life, has attracted popular interest to the usual neglect of three fundamental features of fire prevention and protection which ordinarily impresses only the insurance companies and the owners of the large property values destroyed (about $250,000,000 annually in the United States). This fire by the circumstances attending its origin, spread and destruction of life forcibly illustrates:

First. The prevalent neglect of ordinary precautions to avoid the outbreak of fires due to readily preventable causes.

Second. The necessity of adequate facilities, particularly automatic sprinklers, to extinguish fires in their incipiency, especially where the nature of the work done and materials used may readily cause fires and rapidly spread them.

Third. The importance of fire towers suitable for the prompt escape of the occupants and likewise to afford the Fire Department a safe station from which to efficiently fight fires at close range. Note that the powerful stream directed from the street toward the tenth story, as shown in Fig. 1, is practically vertical and cannot possibly reach a fire on the inside even a few feet back from the windows.

Recommendations.

(1) A fire drill and private fire department should be organized among the employees of all factories to prevent panic and extinguish fires. The plan of organization outlined in the recommendations of the National Fire Protection Association should be used as a guide for this purpose.

(2) All stairways or a sufficient number of them should be located in fireproof shafts having no communication with the building except indirectly by way of an open-air balcony or vestibule at each floor. Hose connections attached to standpipes should be located on each floor in the stair towers for public or private fire department use.

(3) Stairs, if any, inside the building, and elevators should be enclosed in shafts of masonry and have fire doors at all communications to floors.

(4) The provisions ordinarily necessary for fire-escape towers might be somewhat modified in buildings equipped with a system of automatic sprinklers installed according to the standards of the National Fire Protection Association.

(5) Present buildings with inadequate fire-escapes should be provided with automatic sprinklers and (or) smoke-proof stair towers, but *additional outside fire-escapes passing in front of or near windows should be discouraged.*

(6) No factory building containing inflammable goods in process of manufacture, or employing in excess of a limited number of operatives (limit to be definitely fixed), should be without automatic sprinklers. No building over 60 ft. high and containing inflammable goods, where a considerable number of people are employed, should be without automatic sprinklers.

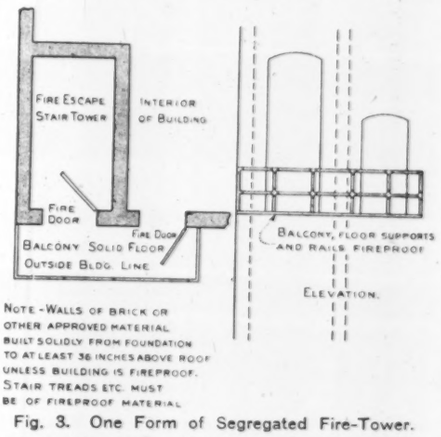
Fire Escape Stair Tower
Interior of Building
Fire Door
Fire Door
Balcony Solid Floor
Outside Bldg. Line
Balcony, Floor Supports and Rails Fireproof
Elevation.
Note.—Walls of brick or other approved material built solidly from foundation to at least 36 inches above roof unless building is fireproof. Stair treads etc. must be of fireproof material

Fig. 3. One Form of Segregated Fire-Tower.

(No opening from stair-well into interior of building. Access by outside balconies. Recommended as the most effective form of safety exit.)

(7) Automatic sprinklers should be installed in high buildings to control a fire and thus prevent it from spreading rapidly from floor to floor by way of outside windows. The use of wire glass in metal frames for all exterior windows would also retard such vertical spread of fire but not so effectively as a complete equipment of automatic sprinklers throughout the building.

THE SIMPSON WELD FOR ARMOR PLATE is described in the "Engineering Supplement" of the London "Times" of March 29 as a method of joining two steel plates together by means of layer of copper placed between them and melted into the steel. Thus the process is somewhat similar to ordinary brazing. The "Times" states that some three years ago Mr. W. S. Simpson discovered that when two steel plates with a layer of copper between were placed in a mixture of carbon, brown sugar and water, of the consistency of compressed snow, and the whole mass heated to 2,000° F., the copper melted away into the steel and a perfect weld of the two steel plates resulted. Examinations of such welds were made by Prof. J. O. Arnold, of the University of Sheffield and appeared to show that there existed at the weld a solid solution of copper in steel, which solution was molecularly continuous with the body of the steel itself and was, moreover considerably stronger than the main body of metal, so that welds made by this method had apparently an efficiency of more than 100%.

The application of this process to the making of armor plate consists in welding thereby a thin plate of extra hard steel, such as the high-speed steel now in general use for metal-cutting tools, upon the face of a thick plate of soft, tough steel. This would give an armor plate resembling those made by the face-hardening processes in common use, with the advantage that a harder face could be applied and could be made of any desired thickness. It is reported that trials made with plates consisting of 2 ins. of hard steel Simpson-welded to 4 ins. of soft showed satisfactory resisting qualities. The "Times" states, however, that in spite of reports to the contrary, no Simpson armor has yet been used on a British warship.

A Reinforced-Concrete Arch Bridge With Separately Molded Members.

A highway bridge of a somewhat novel type has recently been completed for the San Diego Highway Commission over the San Luis Rey River, near Oceanside, Cal. The bridge is a novelty in design and construction in that it was made up almost entirely of separate concrete members molded on the ground at the site and hoisted into place to form the completed structure. This type of arch was devised by Mr. W. M. Thomas, Assoc. M. Am. Soc. C. E., and first put into use in the bridge at Santa Cruz, Cal., erected some years ago. Its claim of superiority rests mainly on its cheapness of construction, as will be shown by the following facts in connection with the San Luis Rey Bridge.

The San Diego Highway Commission's specifications were for a 600-ft. combination wood and steel bridge at this site, with an alternative advertisement for a reinforced-concrete bridge. Bids on the combination of wood and steel bridges ran from $13,000 to $16,000, and a bid was presented for a reinforced-concrete bridge designed under the Thomas system 690 ft. long for $20,500. This extra length carried the bridge proper nearer to the top level of the valley, and thus obviated the necessity for a considerable amount of cutting and filling which would have been required by the shorter structures. It so happened, therefore, that the $20,500 bid was several thousand dollars cheaper than the total cost for a wood and steel structure with its consequent approach work. The Commission therefore decided to accept the bid for the bridge on the Thomas system. As the road surface is 18 ft. wide, the price per sq. ft. of road surface was only $1.65.

A general view of the bridge is shown in Fig. 1. As is there seen, it consists of six arch spans, four of which are 103 ft. long and two 107 ft. long, but all with a rise of 19 ft. Each arch consists of two arch ribs spaced 11 ft. c. to c. and hinged at crown and spring. The roadway, a reinforced-concrete slab, is carried on vertical columns resting on the arch ribs, and both ribs and columns are tied together by cross-beam braces. Except for its lightness, the finished structure does not appear very different from a number of bridges that have been built, but its main novelty lies in the fact that the arch ribs and the spandrel columns are all separately-molded pieces.

The piers are 26 × 12 ft. in plan, each founded on 30 timber piles driven into the gravel riverbed. The bridge is located across the river about half a mile back from the ocean, so that the tides run back and forth at this point. On this account no danger from scouring is anticipated and the masonry foundations are extended only 3½ ft. below the river-bed. These piers and abutments are of solid concrete and extend only to the skewback of the arches.

The arch ribs were cast in semi-span lengths immediately below the place where they were to be erected. Each half arch is about 57 ft. long, 16 ins. wide and varies in depth from 24½ ins. at the crown to 34½ ins. at the spring. It is reinforced with 12 ¾-in. rods in the main section and with ½-in. stirrups arranged diagonally, as shown in Fig. 2. At each of the spandrel columns a support for the column is provided and rods are left extended from the arch rib in the direction of the column and in the direction of the cross braces for the subsequent connection. Hooks are also provided, as shown, for the handling of the piece.

FIG. 1. VIEW OF THREE-HINGED ARCH CONCRETE BRIDGE ACROSS SAN LUIS REY RIVER, OCEANSIDE, CAL.

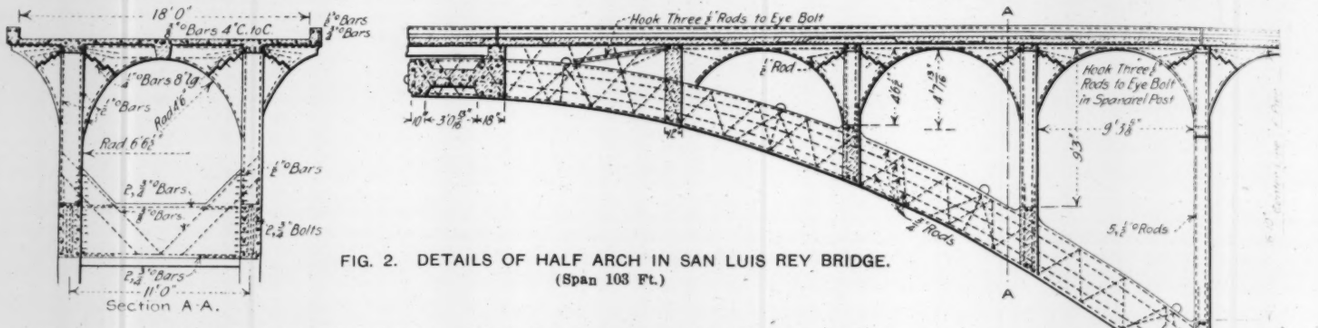

FIG. 2. DETAILS OF HALF ARCH IN SAN LUIS REY BRIDGE.
(Span 103 Ft.)

The spring hinges consist of a ⅜-in. plate bent into a semi-circle of 14¾-in. radius and forming the surface for a semi-cylindrical end to the arch rib. On the pier there is placed a double concave cast-iron casting, of 1-in. metal, with the same circular arc, as the rib end, into which the rounded arch end fits. This detail is shown in the drawing, Fig. 2, and also in the photograph in Fig. 3. Before the bridge is completed this hinge is shielded outside by a facia concrete wall and is also tied across the arch by a transverse rib, as shown in the drawing. The crown hinge consists merely of a ⅜-in. flat steel plate bolted to the crown end of each half rib, with a semi-spherical cast-iron pin 4½ ins. in diameter protruding from one plate and a depression of corresponding size and shape in the other plate.

The spandrel posts are 12 × 16 ins. in section and vary in length according to their position on the arch rib. The longer columns are reinforced with four ⅝-in. rounds, and the shorter with four ½-in. rounds. These rods are left protruding from the sides, bottom and top of posts so that they may tie into the adjoining members when the posts are placed in the bridge. At the bottom the extending rods are provided with a thread, and in the erection they are passed through holes left in the arch ribs and held fast by nuts screwed up tight against the bottom of the arch rib. At the top each post extends in a semi-circular arch in each of the four sections, forming transversely the supports for the floor beam arches and longitudinally the supports for the spandrel arches. As shown by the drawing the tops of these columns are stepped to permit of a sure bond between the columns and the superposed arches.

In the erection a wooden traveler straddling the bridge was used for all the work. This traveler moved on rails laid on either side of the bridge.

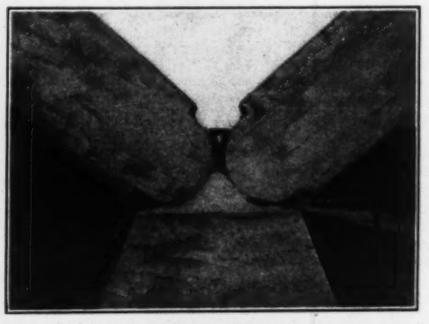

Fig. 3. Close View of Spring Hinges.

The process of erection was very simple, and may be noted from the view in Fig. 4. First four piles were driven under the crown of the arch and then the four arch ribs picked up from their casting table immediately under their proper location in the bridge by the traveler and swung into place in their hinges, resting at the top on the pile bent there driven. Then the spandrel columns were placed successively and held temporarily by cross-timber braces, while the arch falsework for the longitudinal spandrel arches and the transverse floor beam arches was placed. This falsework is supported entirely from the spandrel columns, and the concrete forming the upper works poured to form an integral system with the tops of the spandrel columns.

The floor slab is 5 ins. thick and reinforced with ⅜-in. round rods 4 ins. on centers. It is strengthened by a longitudinal beam running along the center line. The roadway is covered with a 2-in. layer of asphalt, and a pipe railing guards the sides.

The bridge was designed for a live load of 2.0 lbs. per sq. ft., and is to be used entirely for highway purposes. The arch concrete was a 1:2:5 mixture, and the foundation concrete was a 1:3:6 mixture. The bridge was built for the San Diego County Highway Commission by the Young Construction Co. of Los Angeles. It was designed by Mr. W. M. Thomas, of Los Angeles, of the firm of Thomas & Post.

Sinking the Tubes for the River Section of the La Salle St. Tunnel Across the Chicago River.

The La Salle St. tunnel for carrying the north and south lines of the Chicago Railway Co. across the main portion of the Chicago River, was advanced by an important step on April 2, when the floating tube for the river section was sunk in place. The tunnel was described in our issue of Jan. 2. The river section consists of a twin-tube steel shell with a lining of reinforced concrete. It is 278 ft. long, 24 ft. high and 41 ft. wide. The steel shell was built (and partly lined) in a dry dock, and towed to a position near the site, where it was moored to a wharf while the lining was completed. When ready for placing, the top of the floating structure was only just above the water surface. At each end were two steel manhole shafts, high enough to extend above the water when the tubes were sunk; these were enclosed in a timber and steel cofferdam extending transversely across the

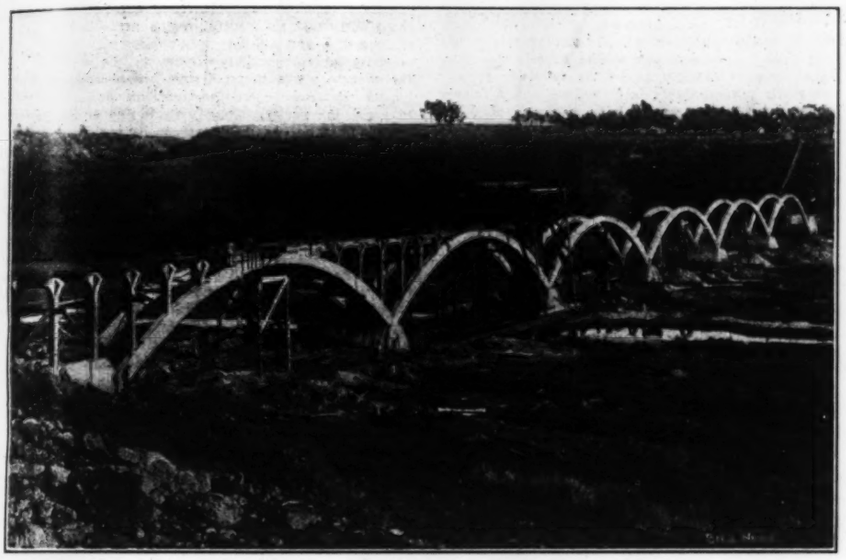

FIG. 4. SAN LUIS REY BRIDGE DURING ERECTION.

structure and afterwards connected with the portions of the cofferdam built at the dock line on each side of the river. A trench had been dredged in the river bed to the required depth, and this proved to be slow work, as it involved the removal of masses of masonry from the debris of the old tunnel which was destroyed some time ago in order to increase the navigable depth of the river.

The first plans of the consulting engineers were to sink the tubes by the admission of water, as at the Detroit tunnel; but to control the sinking by lines from hoisting engines on shore, instead of by compressed-air buoyancy tanks attached temporarily to the floating structure, as at Detroit. With a separate attachment to each corner the lateral and longitudinal positions could be adjusted as required, and the structure held in exact position while a diver put in any necessary shims or supports. This would not involve any obstruction in the channel. The contractors, however, preferred to use lines and tackle from floating scows, and this method was permitted by the railway company.

Near each end of the tunnel tube were placed two scows (one on each side) carrying a pair of plate girders about 75 ft. long, spanning the tube. On each scow was a hoisting engine, with the cable led along the girders to a sheave directly above the side of the tube. The cable was led through a pair of blocks, and its end was anchored to the girders. The hook of the lower hoisting block was attached to a sling of steel cables passed under the tube, each end of the sling being hooked to the cable of a separate hoisting engine. The swift current in the river had been checked by raising the bear-trap dam in the drainage canal, at Lockport, and in still water the floating structure with its four attached scows was swung across the river by tugs, and held in position by pile driver scows. Water was then admitted, the sinking being controlled by the tackle and by regulating the delivery of water ballast. Interior partitions enabled the ballast to be delivered at the ends or middle, as required, and these also prevented surging of the water. The floating weight was estimated at 8,000 tons.

The final position, however, proved to be somewhat defective. In alinement and in longitudinal level the structure was approximately correct, but it had a transverse inclination or list to the west, so that the floor of the west tube was nearly a foot lower than that of the east tube. It is thought that this may have been caused by admitting an excess of water ballast into the west tube; the pressure of the current after the Lockport dam had been lowered may have had some influence also. The list could not be corrected by the tackle, as there was no direct attachment to the tube, and hauling on one side would cause the cable sling to slip under the tube or else it would raise the end bodily. Besides this, however, the scows and floating hoists could not be maintained long in position, as they obstructed a portion of the channel. The position is now being adjusted by reducing the water ballast in the west tube and increasing that in the east tube. The structure is thus being brought into correct position, and the sand filling which will form the permanent bed is being deposited.

The contract for the entire work is held by the M. H. McGovern Co. The company's consulting engineers for the river section of the work were E. C. & R. M. Shankland and J. W. Pearl, but Mr. Pearl (who planned the method of controlling the sinking by lines from shore hoists) resigned before the tube was placed, his plans not being carried out.

PROPOSED STATE ROAD CONSTRUCTION IN Pennsylvania to the amount of $6,000,000, is provided for in a bill favorably reported to the state Senate. The bill provides for 73 new routes besides the 203 previously provided for. Of this sum $4,000,000 is for new construction and maintenance of state highways and $2,000,000 for the continuance of the present plan of state aid to boroughs and townships, but on a different basis than heretofore, the state paying 50% instead of 75% of the cost as under the existing laws. One of the most important provisions of the bill is to have the state take over all toll turnpikes which occupy the shortest routes between county seats. The bill further provides for an increase in the engineering force of the department from 7 to 15 engineers.

The Relations of Isostasy to Geodesy, Geophysics and Geology.[1]

By JOHN F. HAYFORD,[2] M. Am. Soc. C. E.

Within the past ten years geodetic observations have furnished positive proof that a close approximation to the condition called isostasy exists in the earth and comparatively near its surface.

Let the depth within which isostasy is found be called the depth of compensation. Think of a prismatic column which has for its base a unit horizontal area at the depth of compensation, which has for its edges vertical lines, and has for its upper limit the actual irregular surface of the earth (or the sea surface if the upper end of the column is in the ocean). The condition called isostasy is defined by saying that the masses in all such columns are equal.

The adjoining sketch represents two such columns. Column A is under the land and column B is adjacent to it under the ocean. If the condition called isostasy exists in two such columns having equal bases, they have equal masses. Note that if this is true the average density in column A must be less than the average density in column B, for the volume of column A is greater than that of column B. This may be partially expressed by the statement that each excess of mass represented by material lying above sea level is compensated for by a defect of density (and therefore of mass) in the material in the same vertical line below sea level and above the depth of compensation.

The geodetic observations which have furnished a positive proof that a close approximation to the condition called isostasy exists in the earth are, first, 765 series of astronomic observations scattered over the United States from the Atlantic to the Pacific and from Canada to Mexico, and all connected by continuous triangulation,[3] and, second, determinations of the intensity of gravity at 89 stations scattered over the whole of the United States.[4] The geodetic observations show that the most probable depth of compensation is 76 miles and that it is practically certain that it is not less than 62 nor more than 87 miles.[5]

Let the isostatic compensation be considered complete if in every column, such as those shown in the sketch, the mass above the depth of compensation is the same as in every other column. If the mass is greater or less than this in any one column, let us characterize the isostatic compensation as incomplete and measure the degree of incompleteness in terms of the excess or defect of mass.

The geodetic observations show that the isostatic compensation under the United States is nearly complete. It is not merely a compensation of the continent as a whole, it is a compensation of the separate, large, topographic features of the continent. There is an excess of mass in some columns and a defect in others, but the evidence indicates that the average excess in the areas of under-compensation is properly represented by a stratum only 250 ft. thick having the same density as the surface portion of the earth (2.67). Similarly, the average defect of mass in the areas of over-compensation corresponds to a stratum only 250 ft. thick.

Contrast these small excesses and defects of 250 ft. with the actual elevations in the United States, 2,500 ft. on an average for the whole country: If there were no isostatic compensation these actual elevations would represent excesses of mass. The compensation may properly be characterized as departing from completeness only one-tenth on an average.

The recognition of isostasy in a definite and reasonable manner in the computations of the figure and size of the earth from astronomical observations and triangulation has nearly doubled the accuracy of the computed results. This recognition, combined with other improvements in methods of computation, has enabled the Coast and Geodetic Survey to compute the equatorial radius and

[1]Abstracted from an address to Section D (Mechanical Science and Engineering) of the American Association for the Advancement of Science, at Minneapolis, Dec. 29, 1910, printed in full in "Science," Feb. 10, 1911.

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[3]The evidence from these observations is given in full in "The Figure of the Earth and Isostasy from Measurements in the United States" and "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy," both by John F. Hayford and both published by the Coast and Geodetic Survey.

[4]These have furnished evidence which corroborates that from the astronomical observations and triangulation. This evidence has not been published except in brief and incomplete form (report of the sixteenth general conference of the International Geodetic Association, Vol. I., pp. 365-389, "The Effect of Topography and Isostatic Compensation upon the Intensity of Gravity," by John F. Hayford), but it will probably be published in full within a year in a paper which is being prepared by Mr. William Bowie, inspector of geodesy, Coast and Geodetic Survey, and the author. It is expected that this will be published by the Coast and Geodetic Survey under the same title as the report presented at the International Geodetic Association to which reference has just been made.

[5]This is the depth of the compensation if uniformly distributed with respect to depth, which seems to be the most probable assumption. If the compensation is distributed in some other manner with respect to depth, the limiting depth of compensation is different; see pp. 77-78 of the "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy."

the flattening of the earth from observations in the United States alone with greater accuracy than it was formerly possible to compute it from all the observations of the world combined—by such computations, for example, as those made by Bessel and Clark.

Isostatic Readjustment.

MECHANICAL READJUSTMENT.—The evidence is clear that the present isostatic compensation is not an initial condition which has persisted since early geologic times. There is abundant geological evidence that within the interval covered by the geologic record many thousands of feet of thickness of material have been eroded from some parts of the United States and adjacent regions and deposited in other parts, that changes of elevation of the surface amounting to thousands of feet have been produced in this and other ways, and that these changes have continued to take place in recent time. Hence it is evident that if there had been complete isostatic compensation in early geologic time, and no readjustment toward the isostatic condition had taken place since, the departure from complete compensation would now be measured by strata thousands of feet thick upon an average. In fact, the present departures from complete compensation are measured by strata only a few hundred feet thick—250 ft. on an average. It is certain that a readjustment toward isostasy has been in progress during the period covered by geologic record.

Let us consider the tendency of gravitation to produce readjustment toward isostasy. Recur to the case indicated in the sketch. Columns A and B have been assumed to contain equal masses. There is complete isostatic compensation. The pressures at the bases of the two columns are equal, and at any less depth, X, the pressure is greater in A than in B. Now assume that in the normal course of events a large amount of material is being eroded from the high surface of column A and deposited on the low surface of column B. After this erosion has been in progress for some time the isostatic compensation will no longer be perfect. The pressure at the base of B will be greater than at the base of A. The pressure very near the top of B will still be less than at the same level in A so long as the top of A remains higher than the top of B. There will be some intermediate level at which the pressure in the two columns is the same. Call this level of temporary equality of pressure in the two columns the neutral level. As the process of erosion and deposition progresses the neutral level will gradually progress upward from its original position at the base of the columns. Eventually if no interchange of mass took place between the columns except at the surface, and no vertical displacement occurred in either column, the neutral level would reach the surface when the process of erosion and deposition became complete and the upper surfaces of the two columns were at the same level. During the process of erosion and deposition the excess of pressure in A at any level above the neutral level will continually decrease. Similarly, at any level below the neutral level the excess of pressure in B will continually increase as the erosion progresses and the neutral level will rise. Thus there will be established a continually increasing tendency for the material below the neutral level in B to be squeezed over into A. If the stresses tending to produce this undertow from the lower part of B to A become greater than the material can stand, the flow will take place as indicated by the arrow in the figure. If the material flows without change of volume, as if it were incompressible, the upper part of A and its surface will be raised, the upper part of B and its surface will be lowered, the neutral level will sink and an approximation to the original conditions with complete isostatic compensation will be re-established.

This is the general case of isostatic readjustment by the action of gravitation alone. Gravitation tends to produce a deep undertow from the regions where deposition is taking place to the regions where erosion is in progress, in the direction opposite to that of the surface transfer of material.

CHEMICAL READJUSTMENT.—Let us suppose that the isostatic compensation at a given stage in the earth's history is practically complete for a continent, that the process of erosion from the greater part of the continent and deposition around its margins is in progress, and that the process of readjustment by a deep undertow is in progress. These processes will cause changes of pressure and temperature within the earth at certain places. It is important to study the probable effect of these changes upon the condition and especially upon the density of the material involved.

At this point, in order to keep our subject in proper perspective, it is desirable to recall that the average defect in density under a continent corresponding to complete isostatic compensation is 1% or less, the average excess of density under an ocean only about 2%, and the maximum defect or excess under the highest parts of the continents or under the deepest parts of the ocean is but little greater than 3%. These are very small differences in density. Differences larger than these are frequently observed between samples supposed to be alike.

If a layer of material 1,000 ft. thick is eroded from one part of the earth's surface and deposited on another part the pressures must become appreciably reduced for a considerable distance below the eroded region and increased below the region of deposition. The heterogeneous material composing the earth is continually undergoing chemical changes. The expression chemical change is here used in its widest sense, the sense in which it includes the processes of solution, crystallization and changes of state between the solid, liquid and gaseous forms; includes the solution of gas in liquids, the solution of rock ingredients in water and their redeposition as new materials different from the original materials, and changes from an amorphous to a crystalline state, and vice versa. All these and more are concerned in the complicated processes of metamorphism. In the heterogeneous mixture at any point in the earth a great many changes are impending. A relief of pressure at any given point tends to favor such changes as are accompanied by increase of volume and reduction of density, and an increase of pressure tends to have the reverse effect. Many of these suggested chemical changes are accompanied by a change of much more than 3% in density. Changes of this nature in a small part of the material in any cubic mile may alter the average density as much as 3%.

A large reduction of pressure may reasonably be expected, by favoring certain chemical changes within the earth and opposing others to bring about gradually with the lapse of ages a decrease of 2% or 3% in the density of the material relieved of pressure.

Under a region where erosion is in progress or has recently been in progress one should expect, therefore, that the chemical changes guided by reduced pressure will gradually produce increase in volume and a raising the surface; and conversely, under a region of deposition the chemical changes guided by increased pressure will gradually produce increase of density, reduction of volume and a lowering of the surface. The surface changes will then favor more erosion and more deposition in the same regions as before. During this process the stresses due to gravitation, tending to produce an undertow and thereby an isostatic readjustment, gradually increase until an undertow takes place and the isostatic condition is restored or nearly restored. In this last state the surface of the continent will still be elevated, its margins will still be low and the processes of erosion, deposition and isostatic readjustment by an undertow will still tend to continue.

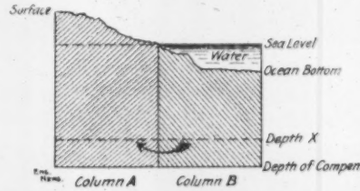


Diagram Sketch of Isostatic Condition and Readjustment After Disturbance by Erosion and Deposition.

TEMPERATURE ADJUSTMENT.—Now consider the effects of the changes of temperature which would be produced by the erosion, deposition and undertow which have been indicated.

Near the surface the temperature is known to increase about 1° C. for each 100 ft. increase in depth below the surface. At great depths the rate of increase is probably much smaller. Assume that it is 1° C. for each 200 ft. on an average down to the depth of compensation, 76 miles. Then if a stratum 1,000 ft. thick is eroded from a region the temperature will be lowered under that region in the course of ages by 5° C. upon an average to the depth of 76 miles. Assuming that the coefficient of vertical expansion is 1 part in 60,000 per degree Centigrade, the material to the depth 76 miles will contract 1 part in 12,000 in thickness or 30 ft. On these assumptions then, for every 1,000 ft. eroded there is a tendency to produce by cooling and contraction 30 ft. of sinking of the surface, that is, one foot of sinking by thermal contraction for each 33 ft. of erosion. It is unimportant whether this ratio 1:33 is a close approximation. It is important to note that whereas the reduction of pressure caused by erosion tends to make the material expand, the lowering of temperature caused by erosion tends to make the material contract, an opposite effect.

Probably expansion by chemical change begins to occur promptly after a certain amount of erosion has occurred, since a change of pressure would probably be felt comparatively promptly even at considerable depths. On the other hand, the cooling is necessarily slow and may require ages to penetrate 76 miles. Hence following erosion in a given region the expansion due to chemical change will tend to begin first. Later, and developing much more slowly, the contraction due to the lowering of the temperature will occur. The latter may in time become as rapid or more rapid than the former, the volume may cease to increase or may even decrease, the surface may stop rising or it may even sink, and the region of erosion be changed into one of deposition.

Similarly, under a region of deposition two ... opposite sign tend to occur. The effect of increa... sure tends to produce chemical changes accom... decrease of volume and so to produce a sinki... surface. The blanket of deposited material tend... the temperature in each part of the material co... increase the volume of this material, and th... raise the surface. The temperature effect may ... time to arrest the subsidence caused by increa... sure or even to raise the surface and change th... of deposition into one of erosion.

FRICTION OF MATERIAL-FLOWS.—The ch... of temperature just described are due directly to ... and deposition. If as an effect of erosion and d... an undertow is started tending to re-establish ... static condition, this undertow, a flow of mate... sumably solid, necessarily develops considera... by internal friction. The increase of temper... produced tends to cause an increase of volume ... favor new chemical changes, including changes ... solid to the liquid state, which may be accompan... change of volume. The undertow tends to be ... not under the region of rapid erosion nor u... region of rapid deposition, but under the compa... neutral region between the two in which neither ... nor deposition is much in excess of the other. H... undertow by increasing the temperature and ... change of density may be directly effective in ... the elevation of the neutral region between two ... of deposition and erosion.

Horizontal compressive stresses in the materi... the surface above the undertow are necessarily ... by the undertow. For the undertow necessarily tends to carry the surface along with it and so pushes this surface material against that in the region of erosion. These stresses tend to produce a crumpling, crushing and bending of the surface strata accompanied by increase of elevation of the surface. The increase of elevation of the surface so produced will tend to be greatest in the neutral region or near the edge of the region of erosion, not under the region of rapid erosion nor under the region of rapid deposition.

There has been indicated a complicated set of changes of pressure, temperature and density and of movements of material beneath the surface, a set of changes which have been started by erosion and deposition and continued by the action of gravitation tending to bring about a readjustment to isostatic conditions. Is it at all certain that under the influence of such actions the geological record at the earth's surface at the end of 50 to 100 million years would be appreciably less complicated than the geologic record which is actually before us? I think that it would be fully as complicated as the actual record.

GRAVITATION THE CHIEF FACTOR IN ISOSTATIC ADJUSTMENT.—How is it possible to form an estimate of the relative effectiveness of gravitation tending to produce isostatic readjustment, on the one hand, and of all other forces acting on the outer portion of the earth, on the other hand? Gravitation is the only force which continuously tends to produce isostatic readjustment. The rigidity of the material tends continuously to oppose the readjustment toward isostasy. Other forces than gravitation are equally likely to help or to oppose gravitation. Therefore, the fact that the isostatic compensation is everywhere nearly complete is a proof, first, that the material composing the outer portions of the earth has but small effective rigidity, and, second, that the forces in operation other than gravitation are relatively ineffective. If either of these propositions were untrue the present close approach to complete isostatic compensation would not exist.

ORDERS TO STOP POLLUTING THE HACKENSACK River and its tributaries were issued by the New Jersey State Board of Health on Oct. 25, 1910, to River Edge, Hackensack, Bogota, Ridgefield, Ridgefield Park, Delford and Englewood. Quite recently representatives of a number of these municipalities met with Mr. Harry M. Herbert, M. Am. Soc. C. E., Chief of the Division of Sewerage and Water Supplies of the New Jersey State Board of Health, and discussed at some length the problem of sewage disposal as affecting the Hackensack River. We are informed on good authority that it seemed to be the unanimous opinion of those present that it would be more economical to build separate disposal plants than to attempt to construct a trunk sewer. On March 28, plans for purifying the sewage of Englewood were submitted by Mr. Clyde Potts, M. Am. Soc. C. E., to the State Board of Health for approval. The above-mentioned order to the communities named, besides citing the statutory authority of the State Board of Health to issue such an order, declares that the Board has inspected the waters of the Hackensack and its tributaries and found that they are being polluted by sewage from the several municipalities "so as to cause and threaten injury to the inhabitants of communities on the river," and orders the communities responsible for the pollution to cease pollution by Jan. 1, 1914, and to "make such other disposition of its (their) sewage as shall be approved" by the Board.

The Mechanical Handling of Freight, Baggage and Mail Matters.[1]

...regard to the mechanical handling of freight, there is ...e progress to report. Such developments as have be... made relate almost exclusively to the handling of car... at steamship piers in ocean and inland ports. Not... appears to have been done in the application of me... al apparatus to ordinary freight-house work.[2] Th... of freight handling at terminals, however, is ent... out of proportion to the low cost of transportation ... odern railway service, and there are possibilities of ... erably reducing this terminal cost by the in... of mechanical appliances.

In connection with the development of freight handling ...steamship piers, it is to be noted that if freight tra...tion on inland waterways is developed, suitable ...s for handling freight and transferring it between ...ts and cars or warehouses will be essential for ...ficient and economical operation of traffic on such ...ways. The plant of the Illinois Central Ry. at M... (noted below) is of special interest on this acco... the arrangement of tracks at steamship piers has ... relation to this matter, and experiments in this ...tion have been made by the Panama Ry.[3]

The handling of baggage and mail by mechanical means is being developed, and has a relation to the matter of passenger station design.

RIVER AND RAIL FREIGHT TERMINAL: ILLINOIS CENTRAL RY.—During 1910 the Illinois Central Ry. has built at Memphis a freight-handling telferage system of special interest, this being used for transferring freight (largely cotton bales and lumber) from Mississippi River steamers and barges to railway cars. The river has a range of about 30 ft. in its water level, and at extreme high water the ground where the new terminal is built is submerged. To enable the terminal to be operated at any stage of the river, an embankment extending above the highest water level is built out from the high ground to the edge of the river bank. On this embankment is a freight platform 30 ft. wide and 300 ft. long, with a track on each side. Along the middle of the platform is built a narrow trestle composed of two-post bents (with inclined posts and short caps). At the river end of the trestle is a four-post steel tower carrying a 90-ft. truss which has a cantilever projection of 60 ft. over the river (Fig. 1). The tower posts are anchored to a concrete foundation block supported on piles.

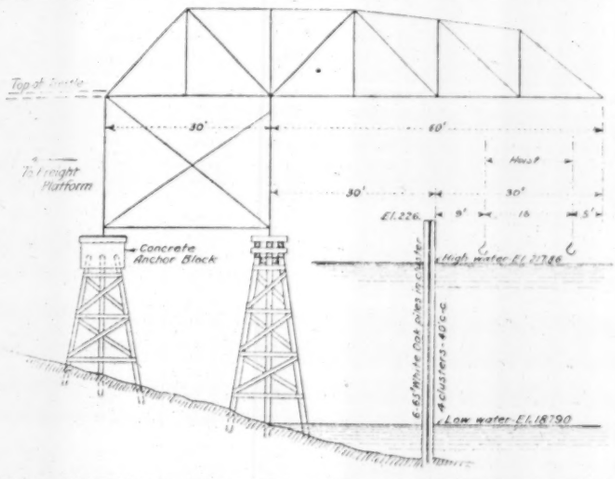


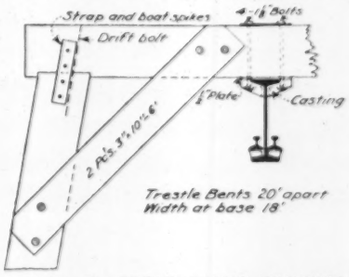
FIG. 1. CANTILEVER TRUSS FOR TELPHERAGE SYSTEM HANDLING FREIGHT BETWEEN STEAMERS AND CARS AT MEMPHIS, TENN.; ILLINOIS CENTRAL RY.

Attached to the bottom of the caps of the trestle and the floor beams of the steel span is a line of 20-in. 60-lb. I-beams, as shown in Fig. 2. On each side of the bottom flange of the I-beam are cast-iron saddles (bolted against the web) which carry light steel T-rails. These rails form the runway for the traveling trolley hoist. This arrangement of runway was adopted because it has been found that where trolleys ride directly on the I-beam flanges, these flanges gradually bend downward. The traveling trolley has two four-wheel 5-ton electric hoists 16 ft. apart, and beneath it is a carriage for the operator. The hoisting speed is 60 ft. per min., and the traveling speed 600 ft. per min. Electric current (200 volts) is taken from an overhead wire carried beneath the caps of the trestle.

A large amount of the freight handled consists of cotton bales, and special low trucks are used for these, each truck holding five bales. These trucks are raised and moved by the traveling trolley, in the same way as the freight trucks at the Old Dominion Steamship Co. pier, described in our report of 1908.[4] The trucks are landed on the platform and wheeled directly to the cars. Logs, timbers, etc., can be carried beyond the platform and loaded directly into flat or open cars on a stub track between the two platform tracks.

FREIGHT CONVEYORS FOR PIERS AND FREIGHT HOUSES.—The Pacific Coast Steamship Co. has at Pier D, in Seattle, an endless traveling ramp or platform for loaded freight trucks. At the Galbraith pier, there is placed close under the roof a conveyor for handling bales of hay; this has a capacity of 400 bales per day.

Traveling platform conveyors have been installed also at Seattle for transferring ship's cargo between the pier sheds and warehouses.[5] The land end of the pier is separated from the warehouse by a street and railway tracks, so that trucking is very inconvenient. The conveyors, therefore, travel on timber truss bridges, which are covered in order to protect the packages from damage. The conveyors handle barrels, cases, hay bales and miscellaneous packages. The platform is 3 ft. wide, and consists of transverse planks bolted to a pair of chains, which pass over 3-ft. sprocket wheels at each end of the conveyor; at one end the sprocket wheel is geared to a 10-HP. electric motor. Cleats are placed at intervals of 3 ft. to hold barrels, etc., in place. At the pier the conveyor rises through the floor (so that it is easily loaded) and then on an incline of 25° to the bridge crossing the street. When handling cement barrels (400 lbs.), these are unloaded at the pier by the steamer's cargo booms, each load consisting of six barrels in a sling. They are landed near the conveyor and rolled directly upon it. With the intermittent supply, the conveyor handles about 360 to 400 barrels per hour, but with a steady supply it can handle from 1,000 to 1,200 packages an hour.



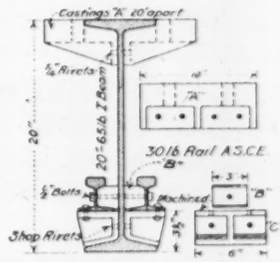


FIG. 2. TRESTLE AND RUNWAY FOR TELPHERAGE SYSTEM.

The Reno inclined elevator is a narrow traveling platform, composed of rows of parallel bars in short lengths, on the same general plan as the moving stairways now in use in department stores, etc. This elevator is placed on fixed inclines between the floors. The side bars of the elevator may have lugs at intervals to engage with the axles of the trucks. Machines 60 to 80 ft. long have been installed in a hay warehouse and in department stores. Another device of the Reno company is a sprocket chain which forms a continuous traveling rack, the teeth of which engage with the axles of the trucks. This is placed on the adjustable inclined platforms or ramps used at steamship piers, and in this case the men walk up the incline instead of riding on a traveling platform. The chain may be lowered beneath the level of the floor of the ramps. Several of these have been installed. The chain runs at a speed of 100 ft. per min. and is driven by a 5-HP. motor. In a modified design proposed for use in freight houses (on the level floor), there is an endless chain beneath the floor having lugs forming a rack upon one side. This rack is under a slot in the floor and each truck has a hinged tongue which may be dropped into the slot to engage with the chain.

FREIGHT HANDLING DERRICKS.—Nearly every large freight yard has a fixed derrick, a crane, a traveling crane, a gantry or other mechanical device for transferring heavy and bulky freight between cars and wagons. The Minneapolis, St. Paul & Sault Ste. Marie Ry. has installed at Minneapolis an unusually large stiff-leg electric derrick for work of this kind.[6]

CONVEYORS AND MOTOR TRUCKS FOR HANDLING BAGGAGE.—The handling of great quantities of baggage is one of the troublesome problems in operating large stations. Reliance is still placed almost universally on manual labor and man-power trucks. Conveyors have been used abroad to a small extent, and it is believed with successful results.[7] The Pennsylvania Ry. has made a start in the introduction of motor trucks, and has a number of these in use at its terminal stations at New York, Jersey City and Washington. In this way the baggagemen are relieved of the hard work of hauling heavily loaded trucks over long distances. The baggageman also rides on his truck, so that greater speed is obtainable even with heavier loads. This expedites the work to such an extent that it has been found possible for the regular staff to handle all the baggage at holiday rush seasons, etc., without the necessity of employing inexperienced men as helpers, who often cause additional troubles from their lack of experience.

The trucks are of the storage battery type, weighing about 2,400 lbs. and having a load capacity of 4,000 lbs. For stations having low platforms, the floor of the truck is above the wheels and practically level with the car floors. For stations having high platforms, the floor of the truck is dropped between the axles and is only a few inches above the platform. The motor is geared to the rim of the wheel and there is a controller at each end of the truck. With one controller in use, the other is automatically made inoperative. There are three speeds (for either direction): two, four and six miles per hour. When the driver steps off the platform on which he rides, the brakes are applied and current is cut off automatically.

The Hudson & Manhattan Ry., which operates an underground electric railway connecting several of the large passenger terminal stations at New York (on both sides of the Hudson River), has special flat cars for transferring baggage trucks between the stations. This saves much time otherwise consumed in loading, unloading and hauling transfer baggage. The cars are of steel, with low sides formed by hinged panels which can be lowered to form aprons bridging the space between the car and the platform, thus allowing the trucks to be wheeled on and off the car with ease.

CONVEYORS AND MOTOR TRUCKS FOR HANDLING MAIL.—The new Chicago terminal station of the Chicago & Northwestern Ry. will have conveyors for handling the mail sacks from inbound trains. These will be placed between the tracks of four pairs of station tracks. They will consist of 26-in. endless belts, placed slightly below the floor level and extending to the branch post-office which is located on the lower or street floor of the station. The belt forms the bottom of a steel trough having sloping sides, the trough being covered by steel plates when the conveyor is not in use.

In this connection we append the following description of the mail-handling equipment at the New York terminal station of the Pennsylvania Ry. This information is condensed from an article by Mr. Joseph B. Baker in the "Engineering Magazine" for February, 1911. It is stated that from 250 to 300 tons of mail are handled daily at this station.—Editor.

Four large plunger elevators provide connections between the mailing platforms and the basement and train-platform levels. Four train platforms and six tracks under the western end of the post-office building, offering room for a maximum of 26 mail cars at one time, have been set apart wholly or partly for the railway-mail train service. All four train platforms will handle mail departing from the station. The south platform is specially arranged for receiving the incoming train mail. Aside from the heavy mails handled on these tracks, there are other mails, light but frequent, for despatch by trains on other tracks. These mails will be sent through spiral chutes or elevators down to a trucking subway 12 ft. wide, extending under the tracks nearly 1,000 ft., provided with transverse branches and connected with the various platforms by means of elevators.

[1] From the report of the Committee on Yards and Terminals, presented at the annual meeting of the American Railway Engineering and Maintenance of Way Association, at Chicago, March 21, 23.

[2] A terminal freight house now under construction will be equipped with a telferage system for handling freight between wagons and railway cars. Designs for other telferage systems were shown in our issue of March 23, 1909. The Baltimore & Ohio Ry. has at Baltimore, Md., a freight pier equipped with the Sprague electric telferage system.—Editor.

[3] Engineering News, Sept. 29, 1910.

[4] Engineering News, March 26, 1908; March 25, 1909.

[5] Engineering News, Nov. 10, 1910.

[6] Engineering News, July 7, 1910.

[7] Belt conveyors have been used in one of the terminal stations at Paris, France. At the Victoria station in Manchester, England, a telferage system has been used; the traveling trolley hoist handles a truck for large articles or a deep basket for smaller articles.—Editor.

To facilitate the rapid transfer of mail from point to point on the various levels, from one level to another, and through the elaborate system of subways, a large number of electric motor trucks have been provided, each having a carrying capacity of 4,000 lbs. The plunger elevators have been designed with sufficient size and capacity to raise and lower these loaded trucks.

Such facilities, however, are not of themselves adequate to provide for the prompt handling and despatch of the enormous quantities of mail (250 to 300 tons per day), comprising from 12,000 to 16,000 bags weighing from a few pounds to 300 lbs.

Two classes of machinery are provided, one for handling the outgoing and one for handling the incoming mail. The mail to be dispatched on outgoing trains arrives at the station in wagons, which are unloaded at the mailing platform. Here the mail pouches are sorted, some of them being sent to the basement level through spiral chutes,* where they are opened and the contents redistributed and finally repouched. The reassembled pouches, together with the unopened pouches, are then fed into spiral chutes, which deliver them to conveyor-belts located at the track level above the mail cars. The belts are provided with automatic trippers or unloading mechanisms, which may be set opposite the door of any of the cars of the mail train, thus automatically unloading and transferring the mail through vertical slides directly into any one of the mail cars for which the apparatus has been set. Two belt conveyors are provided over each of the four mail track platforms, one belt extending east and one west of the connecting spiral chutes, which are constructed with separate compartments, one for each belt. By this means, two mail cars at each of the four track platforms may be loaded simultaneously.

The speed of the apparatus may be estimated from watching the loading of one of the heavy western mail trains which carries the early morning newspapers and steamer mail, together with an enormous quantity of first-class mail matter; this amounts in all to over 50 tons, comprising 1,200 to 1,500 mail pouches. Much of this mail is resorted and segregated for the different cars and despatched from the station in less than three hours, over 25 tons being handled during the last hour, and the bags being frequently unloaded into the cars at the continuous high rate of one per sec. The bags descend the spiral chutes and continuing their journey along the rapidly moving belts, finally emerge at the door of the car, almost noiselessly, the entire journey occupying about 30 secs.

To handle the incoming mails, openings are provided in the train platform into which pouches are thrown from the arriving cars. The mail is then transferred from these receiving hoppers or "loading stations" by means of belts located below the platform floor. Mechanism operated by compressed air is designed to feed the pouches onto the belt at suitable intervals, so that the pouches may arrive at the end of the belt at the proper time to be mechanically transferred to the buckets of a bucket elevator, by means of which they are elevated to the basement and mail-platform levels of the building.

*Spiral chutes for handling freight were described in Engineering News, March 26, 1908.

Engine Driven Generators with Fly Wheel Power Storage to Carry Peak Loads.

A paper by Messrs. Walter Dixon and G. H. Baxter, entitled "Modern Electrical Dock Equipment, With Especial Reference to Electrically Operated Coal Hoists," and presented before the Institution of Mechanical Engineers at London, England, Jan. 20, describes the design of equipment for the Rothesay dock on the Clyde at Glasgow. One feature of great interest lies in the employment of a scheme to eliminate the sharp short peak loads, imposed by the hoisting machinery, by using heavy flywheels on the main generating units somewhat after the schemes developed for motor-generators interposed between mine hoists and a power plant.

This dock is designed for dealing essentially with the shipment of coal and the import of iron ore, limestone and other minerals. The trustees decided to use electrically-operated cranes, capstans, hoists, etc., but the difficulties encountered made it necessary to design an original installation. This apparatus has been so successful for three years that the plant is being extended.

The appliances already erected consist of two 32-ton coal hoists, 18 four-ton cranes, 27 one-ton capstans, two 18-ft. tipping turntables, two five-ton pier-head capstans, an underground distribution system and an electric-lighting installation. In addition, two 32-ton coal hoists and turntables, two 4½-ton transporters, three four-ton cranes and 12 capstans are in the course of construction. It was decided not to use the three-phase alternating-current supply, which was available from an outside system, as power could be generated to better advantage and at a lower cost by direct-current machinery.

The feature of greatest interest lies in the generating machinery. The intermittent working of some of the dock machinery before noted was known to cause extreme peak loads of short duration, and it was seen that if the generating plant was made of sufficient full-load capacity to meet these demands the installation would be expensive and would not run under the most economical conditions. The project of using a storage battery with a booster set was abandoned for a system in which a prime mover was connected to a generator through a heavy flywheel, which takes care of the large peaks due to the coal hoist. The combination unit finally used consists of a specially arranged high-speed triple expansion engine of 450 B. HP. at 320 to 375 r.p.m. Direct coupled to the crank shaft is a direct-current, 440-volt generator having a normal output of 340 E. HP. with a large overload capacity. This machine supplies the ordinary dock appliances and the lighting, and its voltage regulation must be held constant. At the end of this main generator shaft is a special flexible coupling connecting to the flywheel shaft, on which is mounted the flywheel and two coal-hoist generators. The storage of power in the flywheel is so designed that with both hoists working with full load to full height the average demand from the engine should not exceed its normal rated power. By test it was found that these conditions were secured, and with the main generator loaded to about 63% normal output when there was a 20% reduction in speed.

The principal problem encountered was in securing a constant voltage at the terminals of the lighting generators under the varying loads. Some means was necessary of holding up the voltage during the drop in speed necessary to secure energy from the flywheel. The scheme of varying the resistance of the field circuit of the main generator was abandoned for the use of a small auxiliary machine belt-driven from the main shaft and regulating the main voltage.

The flywheel is entirely enclosed in a cast-iron case which was provided for fear that the power required to maintain the flywheel of the two hoist generators at normal speed would be excessive. It was proposed to run the wheel in vacuum. As this power loss proved to be only 20 E. HP. at maximum speed, the installation of apparatus for producing the vacuum was considered unnecessary. When the coal hoists are not in operation, the flywheel set is disconnected from the main generator and engine shaft by the flexible clutch noted.

Notes From Engineering Schools.

RENSSELAER POLYTECHNIC INSTITUTE.—The Pittsburg Building presented to the Institute, by members of the Pittsburg Alumni Association, as an administration building and library will be formally opened on Alumni Day, June 13. This building will cost, completed and furnished, about $140,000. On June 14, Rear-Admiral Robert E. Peary will deliver the commencement address.

OREGON AGRICULTURAL COLLEGE.—An "Engineering Show" was given by the faculty and students on March 17 and 18, patterned after the "Electrical Shows" which have been given in the large cities of the country. This project was called an "Electrical Show," but apparatus and work of civil, mechanical and mining engineers and of foresters was also shown. The civil engineering exhibits were devoted to good roads. The mining engineers showed a collection of ores and minerals and various mining and metallurgical processes. The mechanical engineering department showed the shop-work products of the college and demonstrated testing methods and machines in the laboratories of the building where the "Show" was held. One of the attractions was a 60-HP. Curtiss biplane flyer. The electrical features included exhibitions of high-tension currents, welding processes, wireless telegraphy, electric illumination and electric cooking, etc., etc., in addition to the operation of the regular laboratory equipment. A number of service and supply companies demonstrated apparatus in booths. The exterior of Mechanical Hall, headquarters for the "S..." was illuminated with about 500 16-c.p. lamps. This is the second of these attractions undertaken, and credit for the success of both is largely to Prof. T. M. Gardner, Department of Electrical Engineering.

A COAL MINE EXPLOSION in the Banner mine at Littleton, Ala., April 8, entombed 128 men, none of whom were rescued alive. Of these men, 123 were convict laborers. The damage to the mine itself was comparatively slight, being estimated at $1,200. The mine is owned by the Pratt Consolidated Coal Co.

A MINE DISASTER at the Pancoast colliery in ...coop, near Scranton, Pa., April 7, caused the death of ... persons, one of whom was Joseph Evans of the United States rescue squad. He was suffocated while ...ring an oxygen helmet, presumably due to the failure or interruption of the oxygen supply. The men entombed in the mine were caught by a fire which started in a hoisting-engine room on the lowest level, 750 ft. below the surface. When the fire started, 300 men were at work in the mine. The men killed were in a "blind tunnel," escape from which was cut off by the fire. The bodies of the victims were recovered by the rescue gangs on the day following the disaster. Death in all cases, according to reports, was due to suffocation.

A REPAIR SHOP AND ROUND-HOUSE BURNED at Sanbornville, N. H., April 8, with a loss estimated at $50,000. The buildings were of wood and belonged to the Boston & Maine R. R.

FIRE DESTROYED THE SAW MILL, shingle mill and lumber yard of the Pitt River Saw Mill Co. at Pitt River, B. C., about 20 miles east of Vancouver, March 28. The loss is estimated at $200,000.

THE STEAMER "IROQUOIS" foundered April 10 off Coal Island near Victoria, B. C. Sixteen of the 27 persons on board were drowned. The "Iroquois" is described in press reports as a staunch wooden vessel of 120 tons, built in British Columbia ten years ago.

THE STEAMSHIP "PRINZESS IRENE," of the North German Lloyd line, bound for New York City, ran aground on a sand bar off Fire Island near Sayville, Long Island, April 6 at 3.55 a. m. The captain stated that he had been sailing by "dead reckoning" since April 4. When it went aground, the ship was running at its full speed of 14 knots. On the day following the accident, the 1,720 passengers were safely transferred in life-boats and tugs to the "Prinz Friedrich Wilhelm" of the same line. The transfer of passengers was completed, in spite of the high sea running, in five hours and ten minutes. Assisted by a favorable wind, four tugs succeeded in getting the "Prinzess Irene" afloat again April 9, shortly after 3 p. m. She was apparently not damaged except for a slight injury to her rudder post.

INDICTMENTS AGAINST HARRIS AND BLANCK resulted on April 11 from the Grand Jury investigation into the recent disastrous shirt-waist factory fire in New York City (March 25). The two men were in partnership under the name Triangle Waist Co., and it is claimed they kept the door of one stairway locked during working hours, in violation of the factory laws of the state. They are indicted for manslaughter.

The Coroner's investigation, which has been going on at the same time, is unusual in being in charge of a jury made up of prominent professional men. Charles Sooysmith, engineer, James McKim, architect, and F. E. Conover, building contractor, are among the jurymen.

REMARKABLY RAPID SHAFT-SINKING IN HARD rock was achieved last month in the shaft work just east of the Hudson River crossing of the new Catskill Aqueduct for New York City. The Dravo Contracting Co. is doing the work; Walter Steenburgh was the Superintendent in immediate charge. The shaft is in a difficult location on the west slope of Breakneck Mountain near Storm King station of the New York Central, on the east bank of the Hudson River. It will be the east uptake of the tunnel which is to be the river crossing of the aqueduct. The diameter of the waterway of the shaft (inside of lining) will be 14 ft.; the excavation averages about 16 ft. 2 ins. diameter. On March 8 the shaft had reached a depth of 272 ft., and had been lined to a depth of 251 ft. The month beginning at this point showed the record-breaking advance of 183 ft., or about 6¾ ft. per working day (27 working days). The schedule of working was continuous, three 8-hr. shifts each day

ex pt Sundays. One shift drilled a round, and the other tw shot and mucked it. The material penetrated was a ha granitic gneiss, which required no timbering; the sh was dry and was clear of all obstruction. The sp was handled in buckets running free without guides, by an air-driven hoist. The figure of 183 ft. is the best m on the aqueduct. A depth of 177 ft. in a month a ade at Shaft 1 of the Moodna Siphon, under the c ontractor; this was in Hudson River Shale.

A SUIT AGAINST THE DISCHARGE OF PASSAIC sewage into New York Bay, started some time ago by the state of New York, is not to be discontinued in accordance with the general reports given out at the time. The U. S. Government withdrew its intervention after effecting a compromise with Passaic Valley Sewerage Commissioners. At least, a press despatch from Washington, dated April 10, stated that Mr. Maurice H. Dean, Special Counsel for the State of New York, had asked the U. S. Supreme Court to appoint a commissioner to take testimony. Mr. Dean requested a year for taking testimony. Counsel for the New Jersey interests asked that the time be made shorter. The court took the matter under consideration. If the suit goes to trial, and each side makes the fight that may be expected, it bids fair to equal the famous St. Louis suit against the Chicago Drainage Channel.

THE FIRE AT THE STATE CAPITOL, at Albany, N. Y., in the opinion of the State Architect, F. B. Ware, was probably due to defective wiring, although no official decision has as yet been rendered. The wiring that has been inspected has been found to be defective. Most of the wiring was done nearly 20 years ago, and the insulation had become rotten at the time of the fire. It was found, too, that wires for telephones and call boxes had been run indiscriminately among lighting cables. The fire occurred on March 29 and was noted in our issue of March 30.

THE COFFER-DAM AROUND THE "MAINE" in Havana Harbor has reached the first stage of completion, according to press despatches from Havana dated April 9, all the piles for the twenty cylinders which make up the dam having been driven. The filling of these cylinders with clay has been in progress for some time and is expected to be completed by the end of April. The despatch continues:

> While the simple pumping out of the basin presents no more difficulty than the emptying of an ordinary dry dock, the peculiar conditions of the work make necessary the exercise of extraordinary precautions, which will probably prolong the operation many days. Capt. Ferguson, the United States Army Engineer, is in immediate charge of the operations, and is determined to take no chances. As an additional guarantee of the security of the retaining wall around the basin it is probable that riprap will be dumped around the exterior of the ellipse of caissons before the pumping begins.

In view of the discussion of the "Maine" coffer-dam in our issue of Dec. 29, it is probable that the word "interior" should be substituted for "exterior" in the above quotation.

THE QUEBEC BRIDGE CONTRACT WAS AWARDED finally on April 4 by signature of the contract between the Department of Railways and Canals of the Canadian Government, and the St. Lawrence Bridge Co., the Dominion Bridge Co. and the Canadian Bridge Co. The latter two companies had combined to form the St. Lawrence Bridge Co. for bidding on the work.

The contract is not on the Board of Engineers' design, but on an alternative design of the company. It is stated that the price is $8,650,000, and a bond of $1,279,500 was furnished; the time fixed for completion is Dec. 31, 1915. It is understood that bids on the Board's design and on alternative designs under the Board's specifications were very much higher.

THE MADEIRA & MAMORE RY. and the country through which it passes, are described in an article by Mr. P. H. Ashmead, M. Am. Soc. C. E., in the March "Bulletin of the Pan American Union," published by the International Union of American Republics at 17th and B Sts., Washington, D. C. Mr. Ashmead is Consulting Engineer of the railway, which has already been described in Engineering News of May 22, 1909. Mr. Ashmead states that tracklaying on the railway had reached kilometer 160 in November, 1910, and that the railway is in operation to kilometer 153, as use of this part of the line saves the passage of five falls and rapids on the Madeira River. If the rate of progress of the construction work is maintained, the railway should be completed by August, 1912. The early attempts to build this railway, described in Mr. Neville B. Craig's work, were interfered with by the Indians. It appears, however, that the Indians have now established amicable relations with the railway employees and freely visit the construction camps.

A FOUR-CYLINDER COMPOUND LOCOMOTIVE with all cylinders outside and driving separate sets of driving wheels is a novel design of engine built recently for the Hungarian State Railways. The engine is of the 2-8-0 class, but with the second and third driving axles set far enough apart to admit of placing the high-pressure cylinders between the wheels. The low-pressure cylinders are placed forward of the first driving axle. The appearance is similar to that of a Mallet articulated engine, but all the driving axles are carried in the main frames. The high-pressure cylinders drive only the four rear wheels, while the low-pressure cylinders drive only the four forward wheels. The engine is designed to handle heavy loads on grades of 2.5%, but without very sharp curves. The leading dimensions are as follows:

Driving wheels	4 ft. 9 ins.
Weight in working order	71 tons.
Cylinders, HP. (2)	16½ × 25½ ins.
Cylinders, LP. (2)	25 × 25½ ins.
Valves, piston, valve gear	Walschaerts.
Boiler pressure	225 lbs.
Tubes; No. 272; diameter outside	2¾ ins.
Heating surface, tubes	2,392 sq. ft.
Firebox	146 sq. ft.
Total	2,538 sq. ft.
Grate area	36½ sq. ft.
Length of engine (exclusive of tender)	39 ft. 4 ins.

GOOD ROADS CONSTRUCTION IN LOUISIANA has made considerable progress during the last two years; through the cooperation of the State Highway Department and the local parish authorities, over 98 miles of model roads have been put into service. Of this total about 64 miles of earth road were constructed at an average cost per mile of $823.19. About 29 miles is sand-clay road, which cost on an average $853.54 per mile. The total of gravel road constructed was about 5 miles, and the cost $3,667.43 per mile. These roads were built by convict labor by the State Board of Engineers under the general supervision of the U. S. Office of Public Roads. The State Highway Department was created in February, 1911, as a subdivision of the State Board of Engineers. The above data is taken from a recent report of this department.

Personals.

Mr. A. Bement, M. Am. Soc. M. E., consulting engineer, has moved from the Fisher Building to 206 South La Salle St., Chicago.

Mr. W. G. Evans, President of the Denver City Tramway Co., has been elected President of the Denver, Northwestern & Pacific Ry., succeeding the late David H. Moffat.

Mr. H. M. Hobart, M. Inst. E. E., an author and consulting engineer, of London, England, has joined the engineering staff of the General Electric Co., at Schenectady, N. Y.

Mr. A. C. Adams, recently appointed Superintendent of Motive Power of the Spokane, Portland & Seattle Ry., has been appointed Superintendent of Motive Power of the Oregon Trunk Ry.

Mr. F. E. Bissell, M. Am. Soc. C. E., a consulting engineer, of Cleveland, Ohio, has been appointed Chief Engineer of the Akron, Canton & Youngstown Ry. Co., with headquarters at Akron, Ohio.

Mr. William F. Parish, Jun. Am. Soc. M. E., until recently Chief Engineer of the Deutsche Vacuum Oil Co., of Hamburg, Germany, has accepted a position with The Texas Co., of New York City.

Mr. Max Rotter, M. Am. Soc. M. E., formerly Chief Engineer of the Allis-Chalmers Co., Milwaukee, Wis., has been appointed Chief Engineer of Busch-Sulzer Bros., Diesel Engine Co., of St. Louis, Mo.

Mr. Rosco N. Clark, M. Am. Soc. C. E., formerly Assistant City Engineer of Hartford, Conn., has been appointed City Engineer to succeed Mr. Frederick L. Ford, who resigned as noted in our issue of March 16.

Mr. Henry B. Oatley, M. Am. Soc. M. E., formerly Assistant Engineer of the general drawing room of the American Locomotive Co., at Schenectady, N. Y., has become affiliated with the Locomotive Superheater Co., New York City.

Mr. W. A. Clapp, Assoc. M. Am. Soc. C. E., Civil Engineer and Superintendent of Construction, Quartermaster's Dept., U. S. A., who has been stationed for a number of years in Portland, Me., has been transferred to Fort McDowell, Cal.

Mr. Willard D. Lockwood, M. Am. Soc. C. E., has resigned as Chief Engineer of the M. C. Madsen Construction Co., of New York City, and has organized the Lockwood Engineering Co., Engineers and Contractors, at 50 Church St., New York City.

Mr. Daniel W. Dinan, Superintendent of the Pennsylvania Division of the New York Central Lines, has been promoted to be Superintendent of the Mohawk Division of the main line. He is succeeded by Mr. F. E. McCormack, Superintendent of the Rochester Division.

Dr. S. G. Trauer, Engineer of the Municipal Department of Bridges and Public Buildings of the city of Breslau, Germany, is making a three-months' visit in this country for the purpose of inspecting American public works, especially bridges and rapid transit facilities. Dr. Frauer was the Engineer in charge of the suspension bridge described in this issue.

Mr. F. C. Gamble, M. Am. Soc. C. E., formerly Chief Public Works Engineer and Inspector of Railways for the Government of British Columbia, has been appointed Deputy Minister of Railways of that Province. Mr. Gamble is succeeded as Public Works Engineer by his former Assistant, Mr. J. E. Griffith.

Mr. John G. Glassco, Assoc. Am. Inst. E. E., formerly with the Dominion Power & Transmission Co., at Hamilton, Ont., has been appointed Electrical Superintendent of the Winnipeg municipal electric station at Point du Bois. For the past two years Mr. Glassco has been with the construction staff of Smith, Kerr & Chace, of Winnipeg and Toronto.

Mr. Hermann J. Strobel, Assoc. Am. Inst. E. E., formerly with the New York Central & Hudson River R. R., has accepted a position with the Stone & Webster Engineering Corporation, of Boston, Mass. He will be Assistant to the Electrical Engineer, in charge of the construction of the new generating and substation for the Boston Elevated Ry. Co.

Mr. C. J. Phillips, formerly Superintendent of the Buffalo Division of the Delaware, Lackawanna & Western R. R., has been appointed Superintendent of the Morris & Essex Division at Hoboken, N. J., succeeding Mr. Sydney S. Stone, resigned. Mr. George A. Poore, Superintendent of the Syracuse Division, succeeds Mr. Phillips at Buffalo, and Mr. Frank Cizek, Superintendent at Easton, Pa., succeeds Mr. Poore. Mr. J. J. McCann, Train Master at Scranton, is promoted to be Superintendent of the Scranton Division.

Mr. W. S. Dawley, M. Am. Soc. C. E., Chief Engineer of the Yunnan-Szechuan & Tengyueh Ry. Co., in the Province of Yunnan in China, writes that he has spent a year in making preliminary surveys for 400 miles of line from Yunnan Fu northeast to Sui Fu on the Yangtze River. This is in a very rugged and mountainous country, but he has succeeded in finding a practical route by following the rivers most of the way. He was obliged to make one climb from an elevation of 4,500 to 6,500 ft. and down again to 1,000, with one drop of 1,600 ft. in 16,000 ft.

Obituary.

Harvey Childs Lowrie, M. Am. Soc. C. E., for a number of years City Engineer of Denver, Colo., died in New York City on March 26 from pneumonia. During recent years he had made his home in New York, where he had offices as a consulting engineer.

Thomas Rickard, a mining engineer, of Berkeley Cal., died at his home in that city on March 24. He graduated from the University of California in 1887. He was a brother of Edgar Rickard and a cousin of T. A. Rickard, both of the "Mining Magazine," London, England, and the "Mining and Scientific Press" of San Francisco, Cal. He was 42 years old.

Alonzo H. Linton, once prominent as a railway contractor in the Northwest, died recently at his home in Minneapolis, Minn. He was born in Johnstown, Pa., on Nov. 4, 1836. He entered the railway contracting business in 1854 and later, as the head of the firm of Linton & Co., constructed many miles of road in Wisconsin, Minnesota and the farther West.

Dr. Seaman A. Knapp, an expert of the U. S. Department of Agriculture, died at his home in Washington, D. C., on April 2. He was 78 years old. He was born in Essex County, N. Y., and graduated from Union College in 1856. From 1883-1884 he was President of Iowa State Agricultural College. In 1898 he was sent to Japan, China and the Philippine Islands by the Department of Agriculture to report on the resources of the Islands. He made similar trips later to Porto Rico, Ceylon, India, Burmah and the Hawaiian Islands. He was a specialist on cotton, and since 1902 had been in charge of the "Farmers Cooperative Demonstration Work" in the Southern states.

W. B. Corse, Resident Engineer on the Pacific Division of the Panama Canal, died at the Johns Hopkins Hospital, Baltimore, Md., on Friday night, April 7. Mr. Corse had been seriously ill for several weeks at the Ancon Hospital in Panama, suffering from anemia. He came North with his family on the "Cristobal," arriving in New York on March 30. He was taken at once to the Johns Hopkins Hospital to obtain the benefit of the best medical advice, and it was hoped that the change of climate would be instrumental in his recovery, but he gradually failed from the time of his arrival and was unable to continue his journey to his home in Virginia. Mr. Corse has been in responsible charge on the canal of the work of constructing the locks at Pedro Miguel and Miraflores.

Joseph Wetzler, M. Am. Inst. E. E., who died in London, England, on Feb. 22, was for many years prominent in technical journalism in New York City. He was born

in Hoboken, N. J., on Dec. 6, 1863, and graduated from Stevens Institute of Technology in 1882, when only 19 years of age. He began his journalistic career in 1884 with the "Scientific American." In 1885 he became Assistant Editor of the "Electrical World" and continued to be associated with this paper until 1890, when he became one of the editors of the "Electrical Engineer." He remained with this latter publication until its consolidation in 1899 with the "Electrical World." Mr. Wetzler then retired from newspaper work to devote his entire time to the Electrical Engineer Institute of Correspondence Instruction of New York City, with which he was connected at the time of his death. He was a charter member of the American Institute of Electrical Engineers.

Maj. Heber S. Thompson, M. Am. Inst. M. E., for over 36 years Engineer and Agent for the Girard Estate in Pennsylvania, died on March 9, at his home in Pottsville, Pa. He was born in Pottsville on Aug. 14, 1840. He graduated from Yale University in 1861, at the outbreak of the Civil War. He enlisted as a private on April 16 of that year and was among the first to go to the front. He served throughout the war and was engaged in many of its most important battles. He was a loyal and public-spirited citizen and served his city and state as President of the Board of Trustees of the State Hospital for Injured, in the anthracite coal region, as a member of the Coal Waste Commission appointed by the Governor in 1893, as a member of the State Board of Charities and of other similar institutions and commissions. He was a member of the American Philosophical Society of Philadelphia, the Historical Society of Pennsylvania, the Engineers Club of Philadelphia and other societies.

Arthur Dean Page, consulting engineer, Chicago, died April 7. He was born near Bangor, Me., on Feb. 28, 1866, and graduated from the Maine University in 1886. For several years he was Bridge Engineer of the Great Northern Ry., and in March, 1903, he became Bridge Engineer of the Chicago, Rock Island & Pacific Ry. In March, 1906, he was promoted to the position of Principal Assistant Engineer. He was forced to retire from active work in April, 1909, on account of ill health, and since that time he had been employed in a consulting capacity by various railways and contracting firms. The last important work upon which he was engaged was the design of the Seventh St. viaduct at Des Moines, Iowa, which is being built jointly by the C., R. I. & P. Ry., the C., B. & Q. Ry. and the Des Moines Union Ry. Mr. Page was a member of the Western Society of Engineers, the American Railway Engineering Association and the Chicago Engineers' Club. He leaves a widow and one son, 18 years of age. The body has been taken to Orono, Me., for interment.

Tom L. Johnson, Mayor of Cleveland, Ohio, for four successive terms and famous as a street railway builder, a manufacturer and a champion of popular rights, died at his home in Cleveland on April 10. He had been ill for nearly a year but his condition was not considered serious until about three weeks ago when he began to fail rapidly. He was 57 years old. Mr. Johnson was born in Georgetown, Ky., and was christened Thomas Loftin, although he always preferred to be known as Tom L. from his boyhood days.

His boyhood was spent in Indiana. He began business life in 1869 at the age of 15 as errand boy in the office of the Louisville Street Ry. Co. His promotion was rapid; and several ingenious inventions which he made, among them a nickel-depositing scheme for "bob-tailed" horse-cars, which enabled the services of a conductor to be dispensed with, and an automatic switch, brought him considerable sums of money. When only 22 years old he bought a small horse-car line in Indianapolis, and so improved it by his energy and ability as to make it profitable. A line in Cleveland soon followed.

The introduction of mechanical traction to replace horses soon began revolutionizing the street railway business and Mr. Johnson became a foremost figure in the development of street railway tracks. He invented improved designs of rails and undertook their manufacture himself, establishing rail mills at Johnstown, Pa., and Lorain, Ohio, which proved exceedingly profitable. At the same time, in partnership with a brother, he was engaged in electric railway promotion and construction.

While he thus acquired wealth he became prominent in public life by his emphatic stand against tariff protection to manufacturers and against the exploitation of cities by street railway corporations. He served two terms in Congress from the 21st District of Ohio, from 1891 to 1895, being elected after an exciting campaign in which he advocated the principles of the late Henry George, of whom Mr. Johnson was a life long disciple. In Congress he was a staunch advocate of free trade notwithstanding his large manufacturing interests.

Mr. Johnson disposed of his steel rail business at the time of the general consolidation in the steel industry in 1900 and retired with a large fortune to devote himself to work for the public benefit. He was elected Mayor of Cleveland in 1900, and came into national prominence by his advocacy of three-cent street railway fares. His battle with the street railway companies of Cleveland to secure low fares continued throughout his four successive terms as Mayor, and eventually ended in a compromise. During this long fight Mayor Johnson spent nearly the whole of his fortune in endeavoring to establish the principles for which he stood, sacrificing even his own expensive residence and moving to modest apartments.

Mr. Johnson's body is to be buried in Greenwood Cemetery, Brooklyn, N. Y., in a lot adjoining that in which the late Henry George is buried.

August Bell Milliken, Superintendent of Erection for the Phoenix Bridge Co., died at his home in Phoenixville, Pa., on March 30. He was born at Dauphin, Pa., in 1856. After receiving a good common school education and attending Marysville Academy, his tastes led him to take a position with his uncle, William A. Bell, a pioneer railroad contractor and bridge builder. Beginning at the bottom, he worked his way up step by step, and by actual experience gained an intimate knowledge of the details of field construction work in all its branches, a work in which later on he became a master. He entered the employ of the Phoenix Bridge Co. in 1884 in a subordinate position in the erection department. He was soon advanced to the position of foreman in charge of a party. His unusual ability in organization and the handling of men, coupled with his complete knowledge of every detail of erection work and his good business sense, made his advancement rapid, so that he was soon placed in immediate charge of the erection of the most important structures built by the company.

In 1890 he was appointed Superintendent of Erection, in direct charge of all the field work of the company. In this capacity he was directly responsible for the erection of many of the most important bridges in the United States, a number of them the largest of their kind, at the time they were constructed, and involving novel features of erection which he first developed and executed. Among the number may be mentioned; the Chesapeake & Ohio Ry. bridge over the Ohio River at Cincinnati, Ohio; the Southern Pacific Ry. viaduct at Pecos, Tex.; the Atchison, Topeka & Santa Fe Ry. cantilever bridge at Needles, Cal.; the Omaha Terminal Ry. draw-bridge at Omaha, Neb.; the Chicago, Rock Island & Pacific Ry. double-deck bridge over the Mississippi River at Rock Island, Ill.; the eleven-span plate arch bridge over the Charles River between Boston and Cambridge, Mass., and the elevated railways in New York, Brooklyn and Chicago.

His crowning work was in connection with the Quebec Bridge. In the long critical examination made into the disaster which overtook this structure the highest praise was given to his organization and his executive ability in carrying out the scheme of erection, involving as it did many new and unusual features. Not a single accident had occurred up to the time of the collapse, although the work had progressed through four full working season's and 18,000 tons of metal had been erected, containing single members of 100 tons in weight and hoists of over 200 ft.

Mr. Milliken had that about him which immediately inspired confidence, both in the men under him and in the important officials with whom he was conducting business. He was orderly and painstaking in all his work and a strict disciplinarian, and was absolutely square in all his dealings. Being blessed with a genial frank manner, he made friends readily and greatly enjoyed their companionship. There are many that will mourn his death at such an early age.

Engineering Societies.

COMING MEETINGS.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Chattanooga, Tenn. Secy., D. B. Sebastian, 721 La Salle Station, Chicago, Ill.

AMERICAN RAILWAY ASSOCIATION.
May 17. Semi-annual meeting at New York City. Secy., W. F. Allen, 24 Park Pl., New York City.

OHIO SOCIETY OF MECHANICAL, STEAM AND ELECTRICAL ENGINEERS.
May 18-19. Annual convention at Youngstown, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 23-25. Annual meeting at New York City. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

AIR BRAKE ASSOCIATION.
May 23-26. Annual convention at Chicago, Ill. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
May 23-26. Annual convention at Pittsburg, Pa. Secy., Richard Moldenke, Watchung, N. J.

INTERNATIONAL MASTER BOILERMAKERS' ASSOCIATION.
May 23-26. Annual convention at Omaha, Neb. Secy., H. D. Vought, 62 Liberty St., New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 29-June 2. Annual convention at New York City. Secy., T. C. Martin, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 30-June 2. Annual convention at Pittsburg, Pa. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN WATER WORKS ASSOCIATION.
June 6-10. Annual convention at Rochester, N. Y. Secy., J. M. Diven, 14 George St., Charleston, S. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.
June 6. Annual convention at Glenn Summit Springs Hotel, Luzerne Co., Pa. Secy., Joseph Struthers, 29 West 39th St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 13-16. Annual convention at Chattanooga, Tenn. Secy., Charles W. Hunt, 220 West 57th St., New York City.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 14-16. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 19-21. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 19-23. Annual convention at Boston, Mass. Secy., P. W. Drew, Wisconsin Central Ry., Chicago.

WASHINGTON SOCIETY OF CIVIL ENGINEERS.—At the meeting in Washington, D. C., April 4, Mr. Francis R. Weller presented a paper on "Southern Water Power Developments."

AMERICAN ASSOCIATION OF REFRIGERATION.—The second annual meeting will be held in Chicago, Ill., at the La Salle Hotel May 9-10. The Secretary is Mr. J. F. Nickerson, 315 Dearborn St., Chicago, Ill.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.—The Board of Governors has decided to canvass the membership to learn if a three days' steamship trip would be favorably received for the coming annual meeting. It is proposed to take the trip on Lake Michigan and Green Bay June 27-30, professional sessions to be held on board ship.

CAPT. JOHN ERICSSON MEMORIAL SOCIETY OF SWEDISH ENGINEERS.—This society, organized March 31, 1907, has recently moved into its new quarters in the Engineering Societies Building, 29 West 39th St., New York City. Heretofore all meetings have been held in the Engineers' Club on West 40th St. The present officers are: President, Carl Geo. P. de Laval; Vice-Presidents, Karl Vesterdahl and Frank Mossberg; Treasurer, Gust. Pers Wern; Secretary, Algot Sylvan; Financial Secretary, Birger Nauckhoff; Librarian, John Bergeson; Master-of-Ceremonies, J. E. Friea.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—Papers to be presented at the third annual convention, May 15-18, at Chattanooga, Tenn., are announced as follows: "Fuel Investigations Under the Bureau of Mines," Dr. J. A. Holmes, Director of the Bureau of Mines; "How to Organize a Railway Fuel Department and Its Relations to Other Departments," T. Duff Smith, Fuel Agent, Grand Trunk Pacific Ry.; "The Testing of Locomotive Fuel," F. O. Bunnell, Engineer of Tests, Rock Island Lines; "Standard Locomotive Fuel Performance Sheet," F. C. Pickard, Assistant Master Mechanic, Cincinnati, Hamilton & Dayton Ry.; "The Railway Fuel Problem in Relation to Railway Operation," R. Emerson, Engineer of Track Economics, Atchison, Topeka & Santa Fe Ry.; "Petroleum as Locomotive Fuel," E. McAuliffe, General Fuel Agent, St. Louis & San Francisco Ry. The men named are the chairmen of the committees which have prepared the several papers.

INTERNATIONAL VOLCANOLOGICAL INSTITUTE.—Under this name is being organized a society whose object is "to render possible for the first time a continuous and systematic investigation of volcanic phenomena." The prospectus contains the statement:

* * * * in most volcanoes there occurs a regular sequence of events, and it is within the bounds of possibility and even of probability that a careful and exact registration of all the phenomena of a given volcano will soon enable us to foresee approximately the time and magnitude of an eruption.

Contributions of $5 annually entitle one to receive the publications of the institute. Members contributing $200 or more yearly, or a lump sum of $2,000, are entitled to voting privileges. A subscription list is being circulated qualified by the provision that all signatures shall become void unless $300,000 for the building fund and $10,000 in annual subscriptions is subscribed before Jan. 1, 1912. The founder of the institute is Immanuel Friedlaender, Naples, Vomero, Villa Hertha, Italy, who is in charge of the subscription list.

BROOKLYN ENGINEERS' CLUB.—An exhibit of engineering materials, models and plans of engineering machinery, together with photographs and drawings of important engineering structures, will be held at the club-house, 117 Remsen St., during the week commencing April 17. The exhibits include a variety of subjects, from a model of a refuse-destructor plant to one showing the complete working of a modern fire alarm system. There will be six descriptive and explanatory talks running through four evenings, in which the working and uses of some of the various exhibits will be explained. The engineers of the Public Service Commission will show plans of the new Fourth Ave. Subway now under construction in Brooklyn, together with charts of the progress made and the methods employed. The club-house will be open the greater part of the day and evening during the week of the exhibit.

The regular monthly meeting will be held on April 17, at which Mr. Clyde D. Gray will present a paper on "The Design, Construction and Operation of High Tension Electrical Transmission Systems."